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IS THIS A DEGENERATE AGE?

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TOO many writers and speakers, in discussing the intellectual and social conditions of our time, find little of good and a superabundance of bad. Everywhere they discover evidence of individual and social degeneracy. The love of literature and of pure science is disappearing; college training is debased in that the purely intellectual side is neglected for the practical; everything is dominated by an intense commercialism, which destroys men's finer instincts and lowers the general moral tone of the community.

One may not ignore these utterances; nor may he dismiss them flippantly as wailings of disappointed or unsuccessful men, who would make a virtue of necessity. Men's goals may differ, but their ambition is the same; it ill becomes one to scoff at another; scoffing is bred of ignorance as much in the fortune-chaser who ridicules the student as in the student who contemns the man with the muckrake. The indictment against our age has been drawn by men, who, from their standpoint, have been successful and have no grievance against the world. Many of them belong to the class which, for a long period, dominated thought and controlled the policy of nations. Their statements deserve such careful consideration that one does well to inquire whether or not the conditions are as represented and to what extent they are evidence of either intellectual or social degeneracy. The subject is a broad one and, in treating it, one may adopt only the rambling method of the essay, that he may move hither and yon as necessity may dictate.

Prior to the Civil War, our colleges, modeled for the most part

upon German gymnasia, offered such mental training as was supposed to be prerequisite for professional study. But new conditions arose with the close of that war—the country had discovered its mineral wealth and had accumulated capital for development; the world had learned of America, and its surplus population poured in upon us, ignorant of our laws, alien to our modes of thought, yet eligible to citizenship, to a voice in our government. At once, the demand arose for an education adapted to the needs of those who did not intend to become lawyers, clergymen or physicians, who required a broader, stronger training, fitting men to cope with the new difficulties and to solve the new problems.

It is true that, long before the Civil War, many eminent men had recognized the inherent defects in our college system. They asserted that training in classical languages should not be the important feature of college education; that the Roman church no longer controlled thought or education and that Latin had ceased to be the language of learned men, while changed conditions in professional study had rendered thorough knowledge of Greek equally unessential, so that those languages should be replaced by others as necessary now as those had been. The colleges themselves had recognized the transition and Latin and Greek were taught, with few exceptions, not with a view to impart knowledge of the tongues but with a view to mental training. In other words, Latin and Greek were employed for mental exercise as Indian clubs are employed for muscular exercise in a gymnasium. But no material change was made in curricula; natural science was introduced, but was taught in a most elementary way, while the most precious years of a lad's life were spent as before in monotonous study of paradigms and syntax.

The abrupt demand for better education found our colleges unprepared to meet it. The faculties were composed for the most part of men trained after the accepted method, students by habit, living in a cosmos of their own and conceiving of the outer world very largely as they constructed it on *à priori* principles. As they knew practically nothing about the conditions which made a radical change necessary, the demand was like a rude awakening. Makeshifts were offered as tubs thrown to a whale; subjects dealing with everyday life were introduced into the 'regular' course and the student was led to think in a somewhat 'lower intellectual plane,' that is to say, more nearly in accordance with the actual condition of things. Under the old system he was in the nineteenth century world, but very truly not of it; under the modified system, he was permitted, during part of the college hours, to be actually in touch with it; facts were dealt with sometimes in political economy, a bit of physiology found its way into psychology, the chemistry of common things became a legitimate subject of dis-

cussion. So-called scientific courses were added in many cases, but usually they were so ill-adjusted as to be laughing-stocks for those taking the formal courses.

But mere makeshifts could not suffice; the country's material development was advancing rapidly but not always profitably. Competent men were too few; the successful pit-boss was a poor mining superintendent amid novel conditions; the land-surveyor was helpless in a new region; the iron-founder of high repute proved himself a hopeless blunderer when tried on strange ores and furnaces. The successful men were those who had been trained in the American technical schools or in those of Germany. Their success marked out the line of needed preparation and emphasized the demand for men broadly educated in principles as well as in practical applications of science. Schools were established and courses planned to meet the requirements. The number of scientific and technical students increased rapidly, and, in not a few institutions, soon exceeded, as it does still, that of students adhering to older so-called literary courses. Certainly this condition affords good ground for the complaint respecting college education.

Yet not so. The desertion of the, so to speak, unapplied side is apparent, not real. There is no such desertion. Unquestionably, of the students now in American colleges and high schools, the percentage taking modified courses of the older type is much smaller than it was forty years ago; but that is not the proper percentage for use in comparison. Not relation to the total number of students but relation to the total population is the basis for comparison. From this standpoint one sees that the proportion adhering to the unapplied side has increased more rapidly than the population—indeed, one may make a greater restriction and say that the number of those taking classical courses has increased out of proportion to the population. There has been no decrease, on the contrary there has been an increase, of interest in literary study, while, on the other hand, thousands are acquiring mental training and much of mental culture by pursuing difficult courses almost unknown to our colleges of forty years ago. Formerly, the majority of college men had professional life in view; now it is 'the thing' to have a college degree, without reference to one's intended calling.

But this avails nothing. The proof of the pudding is in the eating; and we are told that no great poet now lives among English-speaking peoples and that in our country no eminent writer has arisen within two decades—this, because 'every man's mind is turned to material things.' Recently our patriotic pride was wounded by the announcement that America has produced no Shakespeare, no Newton, no Copernicus, no men of some other kinds—and this, too, because of our devotion to gross things. One may remark here, parenthetically, that

when we consider that, in all the centuries of English-speaking times, the race has produced only one Shakespeare, the condition is not so saddening as it might be; the less so, since in our own day our country has produced a Newcomb in mathematics, a Rowland in physics and others in other branches of pure science, each of whom deserves a niche, not far, at least, from that of Newton. Were Newton living in the United States to-day he would have no lonely preeminence, he would be but one of a galaxy. A later writer tells us that now, instead of the fires of the creative imagination, we have the fires of the mogul engine —that we cannot have both at the same time.

The creative imagination in the limited literary sense was most unfettered amid primitive conditions, when rhapsodists such as the authors of Homer, the Sagas or the Kalevala chanted the exploits of gods or heroes. As men's experience widened, as their concepts increased in number, as their thought became philosophic, the product of imagination changed in form as well as in character until it dealt not with environments familiar alike to man and beast, but with broad principles. The poem in simple form, possibly the most beautiful form, appeals to the childlike side of our nature. Great poetical works, such as those of Shakespeare and Milton, appeal to us not because of their poetic form, not so much because of their imagery as because of the subtle philosophy which pervades them. Milton appealed to very few in his own day as a poet; he appeals to not many more in our day. Shakespeare's wit has been equaled by later dramatists; his constructive skill has been excelled by some; but his critical insight into human nature remains without rival. The Shakespeares and Miltons of our day write in prose.

Works such as those of Shakespeare and Milton would be an anachronism in our day. Men read carefully, thoughtfully; they think quickly and, as compared with earlier times, accurately. Arguments clothed with rhetorical figures have little power—one has not time in which to scrape off tinsel in order to reach the substance. Reading matter must be trivial or serious; if trivial, thoroughly so, that it may while away hours of weariness; if serious, it must be deserving of study; working hours are too few to be wasted on that which brings no reward. Here one finds reason for the remarkable sale of ephemeral works as well as for the equally remarkable sale of important works. There could be no better evidence of the intellectual growth in our day, a growth not confined to the more favored classes, but characterizing all from the richest to the poorest. Doctrinaires may sneer at the reading propensities of the working classes and may assert that little good can come from reading the stuff which they choose. Others recognize gratefully that the novels now read by such people are better morally and intellectually than those which served as mental food for the more

favored classes of a century ago. The vastly increased number of students in our colleges and high schools is but the natural outcome of this intellectual growth.

Unfortunately, this condition gives room for apprehension; the increase in number of students is said to be so far out of proportion to the population that there is danger of over-education; the professions will be overcrowded with ill-paid workers, who might have gained a comfortable living in other callings. This foreboding is not new; it was old a century ago and was as true then as it is now. Many good men, mistaking their vocation, have gone into professions, though fitted by nature to be only hewers of wood and drawers of water, while others have wasted their lives in professional work, who would have been successful as merchants. There is no danger that the condition will be worse because of increased facility for acquiring an education.

If higher education were merely preparation for service in the so-called learned professions of law, medicine and theology, there might be room for anxiety. But higher education has no longer an aim so narrow as that—it is not to meet the needs of the few, it is to fit the many for life's work. Fifty years ago, college life certainly tended to unfit men for the sterner realities of life, for the whole course of training was as far removed as possible from relation to the ordinary conditions; but not so to-day. For the most part, college professors are no longer recluses; they are expected to take part in social movements; even in politics; many of them, especially of those on the scientific side, are interested in vast business enterprises, partly because they gain greater opportunity for investigation and partly because, as investigators, they need incomes greater than the meager salaries paid by colleges. Training by such men is very different from that by closet students.

All this is conceded, but only that one may make more strongly the assertion that everything looks to the practical, that real culture is neglected, that we are living on the literature of an earlier generation, for nothing new is produced. The difficulty lies in the vagueness of the terms 'culture' and 'literature.' The writer has made diligent search among college men for a clean-cut definition of 'culture.' The results are not wholly satisfactory. Among professors, there is a tendency to regard culture as that mental condition attained through close application to the studies embraced within the definer's department; some in professional life appear to think that it is a something acquired only by close application to such studies as have no practical application; they are inclined to deny the title of culture study to modern languages; had they lived a century and a half ago, doubtless they would have denied that title to the ancient languages, which at that time were studied solely with a view to use; a great majority of the older college graduates maintain that it is that peculiar mental

polish derived from pursuit of the old classical course, and regard themselves as examples—a comfortable frame of mind, truly. Evidently mental culture and mental refinement are synonymous terms to most of those who use the former term, but this is not sufficient; mere refinement must not be all, there must be strength in addition. The all-important culture studies are those which make also for robustness, which enable a man to see broadly, to make inductions safely and to tell to others clearly what he wishes to communicate. Such studies are taught now as never before and with them are taught, also as never before, other studies which make mostly for refinement. A boy entering college to-day must have better acquaintance with history and English literature than had seniors in most of our colleges fifty years ago. Long steps have been taken by several of our States toward making law and medicine actually, instead of nominally, learned professions. Men must have some education before entering upon professional study.

Similarly, the significance of 'literature' must be made definite; it changes with the times. Medieval literature consisted almost wholly of treatises upon harmless topics—such as involved no danger of dispute with church authorities; after the revival of learning, literature was based chiefly upon the newly revealed classics of Greece and Rome; still later, historical disquisitions and philosophical discussions in various forms made up the mass—in each period, that mass concerned matters then most widely interesting. The survivors of each preceding period must have chanted jeremiads over the intellectual decline. In our age, those who love the poem, the essay, the drama, the polished novel and philosophical history, written with a purpose, do find themselves lost. They cannot see good in the development of a new literature, embracing philosophy, archeology, sociology, the natural sciences—a strong literature, often as polished as the old, and showing on the whole a virility unknown even fifty years ago. It reflects the spirit of the age, it is truthful, accurate, honest.

And this brings us to the essence of the whole matter. Stripped of all incidentals, the assertion is that, neglecting mental culture, we have been led to neglect man's higher interests; we have fallen into a slough where everything is subordinated to gain and the rights of man are not regarded; a grasping selfishness brings about combinations in manufacturing interests and makes possible the accumulation of vast fortunes; a base 'commercialism' pervades all society; the body politic is corrupt and honesty has well-nigh disappeared.

The charge that mental culture has been neglected has been considered; it is not true. The other charges remain.

For one hundred years the civilized world has been undergoing repeated transitions. At the beginning of the nineteenth century men lived in quiet; there was no haste. With unfavorable wind, a sloop

might require five days instead of two for the voyage from Albany to New York, just as a vessel, under similar conditions, thirty years later, might be six or seven weeks on the way from London to New York; but the delay caused little more of irritation among the passengers than would be caused to-day if the Empire Express were two hours late. Even sixty years ago, a journey to St. Louis was an undertaking equal to that of crossing the ocean; in each case, the expectant traveler made his will and his friends assembled to bid a sorrowful farewell. Now one makes less preparation for a tour around the globe. Sixty years ago, mails were irregular and postage was from ten to twenty times what it is now. The arrival of a stranger in a village was an event; he brought information from the outer world. The man who had been one thousand miles from home, received more consideration in a large town than is granted in a petty hamlet to a full-developed globe-trotter. Even sixty years ago, forges or petty furnaces, scattered about the country supplied the necessities of the community.

But steamboats, railways and telegraphs brought all parts of the land into actual contact; the discovery of petroleum and the cheapening of kerosene by improved methods of refining carried light into the most secluded corners, and added several hours of life to each day among farming communities; the vast expansion of manufactures during the Civil War led to modifications in educational methods, which in their turn made possible the utilization of our mineral resources. Each advance made others imperative. The repertoire of discoveries in physical science was ransacked in search of those which could be utilized by inventors; every discovery, every invention was welcomed and tested.

Improvements followed in such rapid succession that one, in reviewing the last thirty years, becomes confused and the movements appear as irregular and unrelated as those in a quickly-revolving kaleidoscope. The age of Holley-Mushet-Bessemer steel burst upon us and revolutionized not merely our railroad systems but also our ship-building and architecture. Henry's telegraph, introduced by Morse's energy and Vail's receiver, was spread as a network over the whole country; the researches of Helmholtz and Lissajou led up to Bell's telephone; Faraday's discovery grew into the dynamo, which introduced the age of electricity.

But these changes made more of life, thrust more into life so that more was required of life. The transition or rather the series of transitions was severe. It is the commonplace of history that no great advance is made, except, for the time, at the expense of human life or comfort. Steamships have driven from the sea fleets of vessels and have made the sailor almost a thing of the past; railroads destroyed the prosperity of communities bordering the great turnpikes crossing Maryland, Pennsylvania, Ohio and Indiana, and compelled abandon-

ment of the furnaces whose ruins have been described as picturesque additions to Pennsylvania's scenery. The sewing-machine caused untold misery, as did the power-loom, the shoe-machine and other inventions, which the world now regards as unmixed blessings.

Progress in manufactures, combined with increasing ease of communication and transportation, made the business world more compact and intensified competition. The struggle for existence led to frequent changes in method, at once destructive and constructive. In iron manufacture, small furnaces soon brought only loss to their owners; in trade, the small shopkeeper, who idled for half the day waiting for chance customers, found himself neglected. The story was alike for all. The owner of the petty furnace, like the keeper of the petty shop, was displaced by his more energetic rival, who recognized the coming change and so arranged that by smaller percentage profits on greater sales he might secure increased profit on his business capital. Men may groan in bitterness of spirit as they please, they may denounce the avarice of a manufacturer who sees fit to make the iron and to convert it into the finished product, all within one plant; or that of the merchant, who chooses to sell dry goods, shoes, groceries and hardware on a great scale under one roof; they may denounce, if they will, the man who, having gained the advantage over his less energetic neighbors, strives to prevent another from depriving him of it—the denouncing amounts to nothing. The condition is normal to the advance of the race, for, while bringing disaster to the few, it brings increasing comfort to the many. The energetic man, other things being equal, wins in the race for money, fame, usefulness; in this world every man receives practically full pay for the net average of his abilities. This is nature's law; no legislation avails for its repeal.

This is not the place to discuss the propriety of placing limitations upon combinations of manufacturing interests; the wisdom of permitting the accumulation of vast fortunes; the justice of permitting such fortunes to be inherited so as to support descendants in idleness or dissipation. Such questions are irrelevant in this connection, for we have merely to ascertain whether or not the commercial development of the last half-century has led to a lowering of the moral tone and to the injury of mankind.

Just here one may halt. The term 'commercialism,' like 'culture,' is so vague, so comprehensive as to be elusive. It certainly is serviceable. If a man fail to secure funds for some object dear to him, the failure is not due to any deficiency on his part or even to the nature of the project, but only to 'commercialism.' In such cases, the term is usually synonymous with common sense.

But in a broader way, the term refers to a supposed general deterioration of personal honor, due to the commercial life of our com-

munity. As the whole commercial system is based upon buying and selling, men have come to regard all things as fairly objects for barter and to look upon honor as something transcendental. This conception, the foundation for so many pessimistic forebodings, reflects no credit upon the knowledge or good sense of those who accept it and it may be dismissed as purely *à priori*. There never was a time when business honor was so high as now; the whole commercial fabric is based upon it. Whether the moral sense has been quickened or experience has taught that honesty is the best policy, matters not—the fact remains that in business a man must be honest and honorable; dishonest dealing is fatal. Dishonesty certainly exists as it always has existed and as it always will exist until man's nature changes. It is no novelty, for long ago it was asserted that every man has his price. But there is proportionately less now than ever before.

If 'commercialism' be that which destroys man's better part and makes him ready to subordinate everything to success in his ventures, which induces a soulless indifference to the welfare and even rights of neighbors, competitors and employees, surely we have here no nineteenth century disease over whose discovery so great ado should be made. If perverted ambition, selfishness, lack of principle and indifference to the rights of others be what is meant by 'commercialism,' we have but a new name for that which is as old and as widespread as the human race. It is the same thing, whether in the merchant's counting room or in the clergyman's study. When Napoleon asked contemptuously 'What are the lives of a thousand men to me?' his spirit was the same as that of an oppressive employer; the efforts made by the great 'trusts' of to-day to overcome competition differ in no wise from the cutting of prices between cross-road stores of fifty years ago, or the tricky manipulation of ecclesiastical councils in Constantine's time—or even later.

Inordinate anxiety for wealth and for the power which its possessor can wield is not peculiar to the commercialism of our time. It was quite as inordinate in the quiet days of one hundred years ago as in the golden days of Rome. It has always led to oppression and it has always contaminated society and politics. The satirists of Rome inveighed against its evils as bitterly as do the moralists of our day; the Israelites knew the burden long enough before Solomon's day to make proverbs respecting it; it led the Assyrians along many a bloody path in western Asia; the patrician of ancient Italy lusted for gold as earnestly as did the merchant and in modern Italy one can find no distinction in this respect between the noble and the contemned 'commerciante.' Avarice corrupted politics in the golden age of Rome and in the Elizabethan age of England as thoroughly as during the Second Empire of France or during the Croker Empire in commercial New

York. The conditions which some would have us believe due to commercialism are but manifestations of man's fundamental belief that might makes right.

In this twentieth century, when the peoples of this world are no longer isolated communities, when bonds of steel bind all together, when through causes determined in long past geological ages some nations are agricultural, others manufacturing and others still confined to mining, so that all are mutually dependent, modes of thought and expression, proper enough in medieval times, are no longer wise, are truly anachronisms. One exhibits no evidence of knowledge or of good judgment who asserts that a professional life is of necessity purer, truer or loftier in aim than a life devoted to commercial pursuits. It is not long, in human history, since the only honorable profession was that of arms—thence to theology, law and medicine was a far reach and that to commerce still further. Then each caste, like Sophomores in college, avenged its injuries on that below. But that day has passed, never to return, and thoughtful men everywhere recognize that, in all callings alike, success depends on intellectual power of much the same type, and that the old-time distinction between professional and non-professional men exists in name rather than in fact.

Ours is an age of commerce, an age of devotion to material things; but that devotion has none of grossness nor is it in any sense inconsistent with a just devotion to higher things. Thus far, the argument has been largely negative, an effort to show that this age is not worse, but possibly better than its predecessors. The positive argument remains, to show that, because of commercialism, this age on the whole is vastly better than its predecessors.

The twentieth century opens with the establishment of a Permanent Court of International Arbitration, for which the world is indebted to the great commercial nations. The Hague conference was called by the Emperor of Russia, a nation not usually regarded as commercial, but that conference was due primarily to the course of Great Britain and the United States, which had tested arbitration and, by submitting to awards, not always just, had set the example for other nations. Peace between nations depends no longer merely upon armies and navies. War is no longer a matter affecting only the internal affairs of the nations directly involved; it concerns all, for commercial bonds unite all. Divine right of kingly authority is becoming an abstraction; the king bows to his subject and restrains his greed for conquest when bankers refuse to finance his loans. The exigencies of commerce have aroused a public opinion which curbs rapacity and demands arbitration of international disputes. War between Great Britain and the United States is well-nigh impossible—it would lead to financial ruin in both countries. The terrible conflict between Slav and Teuton, for which

so many wait in dread, is likely to remain a nightmare. Great Britain needs Russia's grain; Russia needs the manufactures of Britain and Germany. Germans control Russia's trade even in far-off Siberia, and Germans are teaching Russians how to develop their resources. The rabble in each country may rave as they please—a power mightier than they makes for peace.

The same influence is exerted for maintenance of friendly relations within the commercial nations themselves. Compulsory arbitration of labor disputes has been established in some portions of the British empire and several of our own states have taken the initial step by appointing arbitration commissions to serve when called upon. The trend of public opinion among us was shown during the recent steel strike, when arbitration was urged not only by journals defending the strikers but also by those which denounced the strike as wholly unjustifiable. Individual differences, settled in olden time by combat, are settled now by arbitration before judge or jury in open court; the day is not far distant when differences between organizations, large and small, will be settled in the same way. Here, too, our vast commercial organizations make for peace, since their gigantic interests are so interwoven with the equally gigantic interests of labor that serious interruption of friendly relations threatens destruction to both.

Improvement in politics is not very distinct to those living in our great cities, for the present degradation is of comparatively recent origin and due largely to foreign immigration. Cities, like sieves, permit most of the good to pass through and the worthless to remain, while universal suffrage enables this residuum to convert them into sinks, which receive partial cleansing only when rogues disagree and the 'outs' seek revenge by temporary combination with decent people. Leaving the cities out of consideration as temporary anomalies, one finds that men holding positions of honor and trust are expected to perform their duties faithfully. Charges of corruption are not bandied about freely by reputable journals as they were sixty years ago; in Great Britain and the United States, errors in policy are not charged to venality, but to lack of common sense. Fair dealing is so ingrained in commercial life that we are coming to expect it naturally in political life. 'Senator Sorghum,' the creation of a jester, belongs so much to the past that his utterances afford only amusement. Commercial Britain has the best city governments in the world; its civil and diplomatic service shows a sense of honor as high as that of the American army; within the United States, civil service reform has gone far toward removing the evils of patronage which degraded our politics even less than thirty years ago. It is true that politics here and in Great Britain are far removed from millennial conditions, but another

half-century of equal advance would bring them very near to the ideal condition.

The American employer discovered, long before the missionary, that the condition of a man's body has much to do with his openness to reason. Men, well-fed, well-clad and comfortably housed, are more efficient in every respect than are men scantily supplied and embittered against the dealings of Providence. The recognition of this fact—the recognition of manhood in the employee—is the basis of American commercialism, the true secret of its success. This recognition is less marked in Great Britain, where all are bound by traditions from which men free themselves slowly and with difficulty, but the keenness of American competition is compelling the recognition. In our land, mere animal strength counts for little in man, machinery takes its place; the steam shovel has displaced thousands of hands, but it has made necessary an immense number of intelligent men; our rolling mills are no longer crowded with an army of laborers, dull, sluggish, automatic; the work is done by a, so to speak, handful of men, keen-eyed and alert. Of course, this recognition may be due to no altruism on the employer's part, but that is wholly aside from the issue—we are considering conditions, not motives.

Increased wages came with increased value of service—whether through the employer's wisdom or through compulsion, matters not. Decreased cost of living came with increased wages, for, owing to the introduction of machinery, wages did not keep pace with capacity for production. The condition of the mechanic in respect of food, lodgings and general surroundings has shown steady improvement during the last thirty years. In the United States, food is cheap and abundant; the homes of our laboring classes are better than anywhere else. Away from towns, owners of mines or great manufacturing establishments, knowing that men, to do good work, must be well cared for, build comfortable homes for their employees and charge low rental. Many of them recognize a certain responsibility; they encourage thrift and urge, even assist, employees to own their dwellings. Mr. Carnegie is not the single instance of this type of employer, as many suppose. He was one of the first to develop the plan, but many have followed in his steps. Even in New York city, where the tenement problem is so complicated, owing to the form of Manhattan Island, the accommodations for those with mechanics' wages are inviting, while the wretched conditions in the Italian quarter are, to say the least, an improvement upon those in Naples.

This recognition of those, who in non-commercial countries are regarded as the 'mudsills of society,'—to use the language of an ante-bellum senator from North Carolina—has had a reflex influence upon those living amid more favorable surroundings. One hundred years

ago any hovel answered for the poor man, while the rich neglected what, in our day, are called ordinary sanitary precautions. Now a board of health is an essential part of city government and it has powers which, in other departments, would be regarded as despotic. Problems of ventilation, space of living apartments, sewage disposal and street cleaning are those for the sanitary engineer, whose profession is dignified and requires years of preparation. The hydraulic engineer no longer expends his chief efforts upon quays, harbor walls or dams; those are still important, but far more important are problems relating to water-supply for cities, towns and even small villages. Nothing bearing upon public health is too insignificant for notice; neglect by a traction company to provide closed cars on a cool day awakes editors to write indignantly. Sanitary regulations have led to sanitary living, so that, in spite of the fact that men work more intensely than ever before, they break down less rapidly and fourscore is more nearly man's expectation of life now than was threescore and ten fifty years ago.

The rights of man as man before the law are acknowledged by the two great commercial nations as never before and as by no other nations. A defendant no longer rests under the assumption of guilt; he is innocent until the charge has been proved; a married woman is no longer merged in her husband; in the eye of the law, she is at least her husband's equal. The poor man and his wealthy neighbor stand on a common level in the court room and at the polls. Taxes are distributed justly and the rich, as well as the less favored, bear an equitable share of the governmental burdens.

Having granted universal suffrage, the two great commercial nations have been compelled to recognize man's intellectual needs. They offer opportunity for education to all, even straining the prerogative of government to do so. Education, free from ecclesiastical control, is no longer a privilege obtainable only by purchase, it is the right of every man. More, it is maintained that government is bound not only to offer the opportunity, but also to compel its acceptance. The poorest man has the way open in our land from the primary school to the close of professional preparation, practically without cost. Machiavelli has grouped the people of any nation into three classes—those who think for themselves, always few in number; those who think as others think, the intelligent middle class; those who do not think, the great mass of the population. His grouping is still applicable to Great Britain and the United States, but our schools, our sharp political contests and the wide circulation of journals have led to great changes in the relative proportions of the classes. The growth of liberal parties and the increasing independent vote, with which politicians have to reckon, are manifestations of the change.

Commercialism, leading to such broad results for all, has a marked influence upon those who have led in the advance. American men of commerce, be they lawyers, merchants, manufacturers, bankers or railroad managers, acknowledge the community of interest and seek fame or immortality as philanthropists. They cherish hospitals, they endeavor to improve the condition of the poor, they found universities, they endow public libraries, they establish vast museums. A Howard, a Shaftesbury was a strange phenomenon. There are many Howards and Shaftesburys in our great cities, who, having acquired or inherited great wealth, spend their hours not in selfish indulgence but in devoted efforts to make the world better and happier.

One cannot ignore the fact there are many, whose only enjoyment apparently is found in flaunting their wealth in the face of the poor, but they are no longer objects of admiration on the one hand or of fear on the other; the community looks upon them with mingled pity and contempt. Selfish employers are not unknown, oppression has not ceased, poverty, suffering and crime are on every side; in many respects, the evil more than counterbalances the good; all this we know; but we know also that, in all that makes for good, the condition in the two great commercial nations to-day is far, far beyond that existing in the golden age of Rome or Greece or in the Elizabethan age of England. The very anxiety to relieve the oppressed makes us familiar with the prevailing sorrow and leads those, who under former conditions would have been ignorant or unobserving, to their gloomy pessimism respecting the future.

As for the fires of creative imagination, one may say only that they are as brilliant now as at any previous time—with this difference, creative imagination is about better business now than formerly—it no longer wastes itself in cultivating merely the esthetic side of man, it works for his uplifting, physically, morally, intellectually.

THE FORMATION AND MOTIONS OF CLOUDS.

By Professor FRANK H. BIGELOW,
U. S. WEATHER BUREAU.

THE most beautiful objects in the sky are clouds, and their daily procession from west to east in northern latitudes forms a moving tableau of living pictures for those who have eyes to see. The glories of the sunrise and sunset, decking the fading stars of the morning and the waxing lights of the evening with the pure colors of the spectrum, elevate the heart of man to a loftier adoration for the marvels of nature, than any works of art prepared by his own hand. The exquisite tints of the twilight in the northern, and the even richer tones of the tropic zones, are painted on the memories of those who have crossed the equator. I have seen on the Island of Ascension a set of spectrum bows spread over the evening clouds, as if several rainbows had conspired to illuminate the heavens at the same moment. There are possibly two or three other objects in the sky that rival or even excel these cloud pictures in delicacy of light and shading. They are the aurora with its quivering beams dancing in the cool atmosphere of the polar night, and the star clusters of the nebulae in the milky way near the Southern Cross, viewed through the great refractors of the south.

Such effects are produced by the prismatic action of the small spheres of condensed aqueous vapor that make up the cloud. The rays from the sun, when it is near the horizon, pass through these crystal spherules at such angles that the emergent light is spread out in numerous spectra. The white light coming from space is singly and doubly reflected and refracted within the surface of each aqueous globule, so as to become separated into the bands of color which correspond to the wave-lengths of the solar radiations. The rainbow is a typical illustration of this process, but an illuminated cloudlet represents a million minute bows intersecting each other in all possible directions. The colored clouds of the morning and evening are bright because the light from the sun passes at proper angles to the cloud, and from the cloud to the observer, through a given thickness of the vapor, till the refracted rays are brought down to the earth. The midday clouds are white and glistening, because the sun's rays pass through them as scattered instead of as refracted light, dancing from drop to drop in zigzag courses till the last reflection brings it down to the eye of the observer.

The formation of the vapor drops that make the cloud was long a puzzle to science, but modern research has at last succeeded in solving this mystery. It has been found by experiments that if pure dry air, and pure vapor of water, be mixed in a clean vessel, and then cooled down below the temperature of saturation, the drops of mist are not generally able to form. Purity means that all the particles of dust which float in the air have been perfectly filtered out, and that all traces of electricity have been removed from the air and the vapor before mixing them. It was further discovered that if fine dust powder is injected into the pure mixture, without changing the temperature or the pressure, the drops of water developed at once; also that if minute charges of electricity, carried on particles of matter which may be as small as one-thousandth part of the mass of an atom of hydrogen, are introduced, the drops are able to condense. It is inferred that nuclei of some kind, dust particles or electric particles, called ions or electrons, are required for the formation of water drops suspended in dry air, one nucleus for each drop. Hence, it is possible by counting the number of minute drops that form in a cubic inch, to estimate the number of motes of dust in the air, and even the number of ions charged with electricity in a given volume. The number of the ions contained in the air may be enormous, ranging from 20 per cubic centimeter to many millions. We perceive further that these minute drops coalesce to form rain, which falls from the clouds to the ground, and that they carry down the dust previously blown up by the winds and so purify the atmosphere from all sorts of small floating particles. They also bring electric charges to the earth, and this has something to do with producing the atmospheric electrical potential which always exists. These ions are a natural portion of the atmosphere itself, being continuously produced in it, even when no special cause seems to be present, and they have much to do with explaining some of the strange characteristics of atmospheric electricity which have so long baffled all efforts to comprehend. Investigators are now paying the closest attention to these ions from every point of view.

After clouds have been formed by the condensation of the aqueous vapor, which has been lifted by evaporation from the surface of water at the earth into the air, they take on very different shapes according to circumstances. They may be broadly divided into two classes, the cumulus type and the stratus type. Cumulus clouds are the fleecy, wool-pack clouds usually seen on a warm summer afternoon; the stratus are the horizontal veils or sheets that cover the sky more or less completely and which may develop into a general rain. The cumulus of the lower strata, one mile high above the ground, may grow upwards so as to form large domes, and in hot weather they become cumulo-nimbus when the heads are very lofty, some having been observed to reach six

or eight miles above the ground. See Chart 2. The alto-cumulus clouds are smaller, more huddled together like the backs of a flock of sheep, and they are from two to three miles high; the cirro-cumulus, from four to six miles high, appear to be still smaller, and they often arrange themselves in ranks or battalions and form the beautiful mackerel sky. All these clouds are formed by the rising of currents of air in a vertical direction, the flat bases showing the level where the temperature begins to be cool enough to cause the vapor to condense, while the sides and tops outline the relative amounts of pressure, temperature and vapor which are just sufficient for the saturation to begin. From a study of these elements we may compute the vertical gradients for each 100 meters, or for each 100 feet, of elevation above the surface of the ground, and these quantities are of great value to meteorologists. The stratus or veil clouds are formed in a very different way. Instead of producing the cooling necessary to condense the moisture by raising it to higher elevations, it may also be caused by the flowing of horizontal currents of air in contact with each other, as when a warm current passes over a cold one. When air from the south flows northward and air from the north moves southward into the same region, these currents generally overflow one another in two strata instead of mixing, since masses of air at different temperatures are quite reluctant to lose their individuality. This stratification of the air in horizontal sheets, flowing from the tropics and from the polar zones, is always taking place in the atmosphere, and the stratus clouds are generally produced somewhere along these surfaces of contact. The cumulus clouds therefore indicate, as shown in Chart 1, that the air is rising vertically in certain layers, while drifting eastward, and the stratus that it is moving horizontally with a different velocity in adjacent strata. The lowest stratus clouds are elevated fog; the strato-cumulus is about two miles high; the alto-stratus averages four miles and the cirro-stratus six miles above the earth.

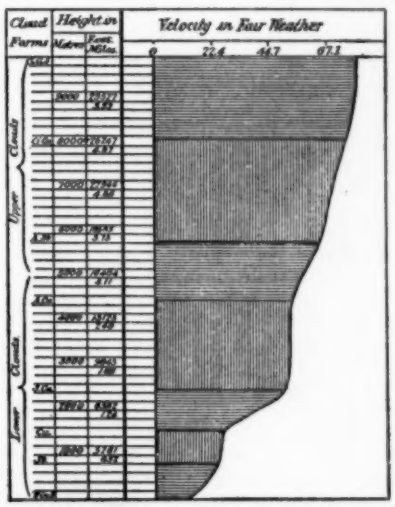

CHART 1. Example of the eastward movement of the upper air above Washington, D. C., in miles per hour. The average eastward velocity at the surface is 6 miles per hour; at 6 miles high it is 70 miles per hour in clear weather.

There is furthermore a stratification of the vapor contents of the atmosphere within every high cumulus cloud, which is interesting.

Take a lofty cumulo-nimbus cloud such as rises in the summer afternoon before a thunderstorm, from whose base rain may perhaps be falling, while the top is even higher than Mount Blanc piled upon the summit of the Himalayas. See Chart 2. There are sections which should be passed through the cloud, so as to divide it into three parts, which in fact differ from one another physically though they look alike to the observer. The lowest plane separates the saturated from the unsaturated vapor and marks the flat base of the cloud; the second is at the top of the saturated part and at the beginning of the freezing stage; the third is at the top of the freezing and at the bottom of the frozen stage. The freezing stratum is thin and is the place where the

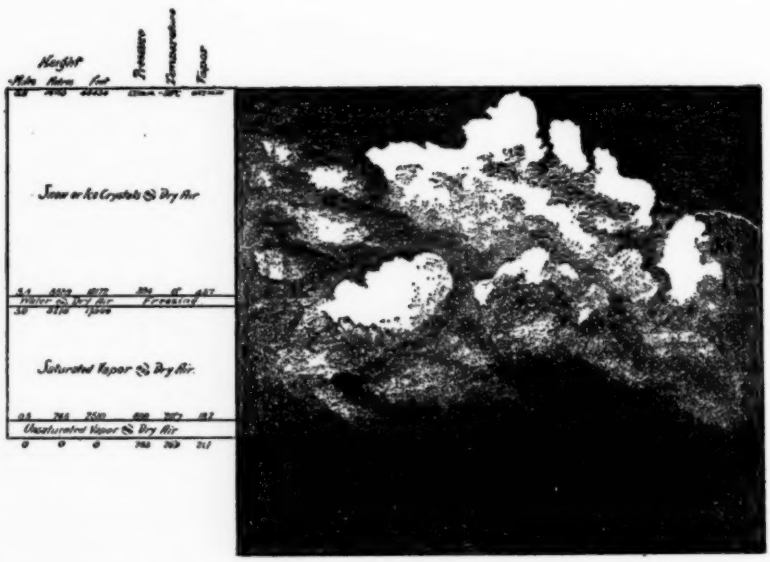

CHART 2. The distribution of pressure, temperature, and vapor tension in a lofty cumulo-nimbus cloud, observed by the Weather Bureau, July 29, 1896.

saturated vapor is passing into water at freezing temperature before it can crystallize into ice. A cloud has, therefore, these three portions, the lower consisting of vapor, the middle of water and the top of ice or snow. They appear to be alike because the light from the sun is reflected from drop to drop and from flake to flake in its passage through the cloud. The diagram gives the pressures, temperatures and vapor tensions at the ground, and at the several stages, while the height is indicated in miles, meters and feet. This illustration is taken from one of the loftiest clouds ever observed, and it was computed that the temperature fell from 26.4° Centigrade at the ground to —59° Centigrade or —74° Fahrenheit at the height of 8.8 miles. In summer time at the top of a high cloud the same temperature prevails that may be

found at the ground in the polar regions during the coldest days of winter. The obvious correction for the suffering of humanity due to the oppressive hot waves of summer is to bring down this upper air, or else arrange to visit it in floating houses.

The reader may have noticed that hail falls usually in the summer instead of in the winter, and have wondered what is the reason for it. The answer is simple. If we arrange a diagram so that freezing temperature is on the left and 100 degrees Fahrenheit on the right, and plot the limits of the rain, hail and snow regions in altitude, the result is shown in a set of curves which indicate the height at which it is possible for them to form respectively. In the summer when the

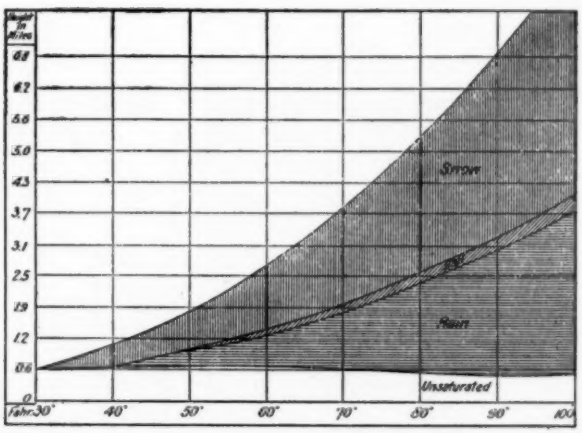

CHART 3. Distribution of rain, hail and snow in the atmosphere according to the temperature and height of formation. The curves mark the average boundaries of the several stages of the moisture in the atmosphere.

weather is warm there is more moisture in the air, it rises higher, till in extreme cases it may reach about seven or eight miles. The stages each become wider, though the hail is always confined to a narrow wedge-shaped region whose highest place is about four miles. Now in thunder-storms when there is powerful congestion and stratification of air currents in a vertical direction, the conditions are favorable for the forming of snow balls first by congealing the flakes in the lower parts of the upper stage; these fall slowly through the freezing stage and are coated with a layer of ice; they drop through the rain stage and collect a thicker covering of ice till they arrive at the ground as hail-stones. Such strata may be intermixed and arranged in alternate layers so that a nucleus of snow may fall through more than one pair of snow and freezing regions in succession, and thus cover itself with several layers of snow and ice, like an onion. Such stratified hail-stones are often found when they are cut open. This theory seems to

account for all the facts that have been noted in a simple and natural manner.

The most important use of the cloud observations is not the study of their constitution, but of their motions relatively to the surface of the earth. A cloud is a meteorological meteor, and moves in the stratum of air at approximately the same velocity as the atmosphere itself, so that a measurement of its direction and velocity gives that of the air current, just as a chip floating on a stream shows how fast the water is running. Repeated measures of this kind, when classified, teach us that the atmosphere flows with certain typical movements, and that by them the laws controlling its average circulation can be deter-

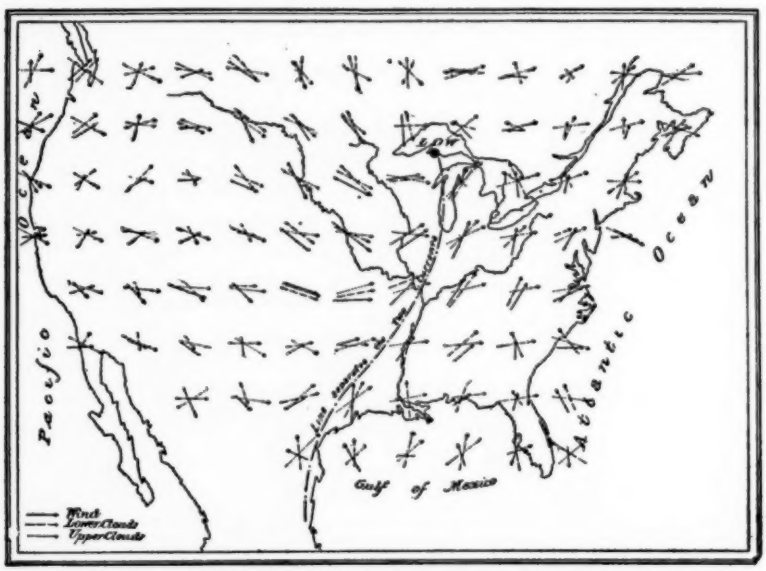

CHART 4. Storm in the Lake Region, a winter cyclone or low area.

mined. Now it is a fact that because meteorologists could observe the motions of the wind readily at the surface of the earth, but not in the upper strata of the air, they have relied too much upon conjecture in constructing the theories of the constitution of storms. The mathematical analysis has had therefore only an imperfect basis upon which to rest, and consequently it has made slow progress towards a complete solution of the problem. The international observations on clouds, during the year May, 1896–July, 1897, had for their immediate object the accurate determination of the motions of the upper air, with a view of testing the existing theories, and constructing new ones wherever necessary. This period of scientific observation is similar to the Tycho Brahe and Kepler stage of astronomy, when observations of the motions of the planets were accumulated for the use of the coming

Newton. To lay out the paths of motion in the atmosphere is just as important a work as that of finding the orbits of planets. There is more difficulty in doing it accurately because the motions of the air are much less steady and symmetrical than those of single masses like planets, comets and meteors, but it can be accomplished by patience and well-directed work. Unfortunately for lack of this sort of data much of our common meteorology is incorrect, and must be laid aside as of only an historical value. The subject is itself very complex, and it is unsuitable for a popular exposition, but an idea can be given of its scope and tendency by reference to the accompanying charts.

The Chart 4, marked 'Storm in the Lake Region' 'Winter Cyclone or Low Area,' is a composite map of the motions of the air around a winter storm central near Lake Superior. The upper or cirrus cloud movements are shown by the dotted arrows, the lower or cumulus, by those drawn with a broken line, and the surface wind by those with one unbroken line. The region affected by this storm extends from the Gulf of Mexico to the Lakes, and from the Atlantic Ocean to the Rocky Mountains. It is noted that the arrows drawn with an unbroken line and those drawn with a broken line generally blow nearly side by side, but that they differ from the dotted arrows in many cases, especially near the center of the storm and eastward to the ocean. This shows that the real storm circulation is confined to the lower strata as if it were quite independent of them. There is seen to be a slight deflection of the dotted arrows southward around the low; a corresponding chart of a high area would show a similar deflection to the northward of the center. This feature is brought out in Chart 5. Direction and velocity of the motions of the air in the cirrus, cumulus and on the surface. The arrows are not very smoothly laid down with reference to one another, but this is due to the fact that there were not enough observations taken in order to smooth out the local irregularities. Still, it is easy to trace a sort of wave motion, a crest over the high and a hollow under the low. As we come down from the cirrus, six miles high, towards the ground the sinuous motion becomes more pronounced, till in the strato-cumulus level the rotary component is dis-

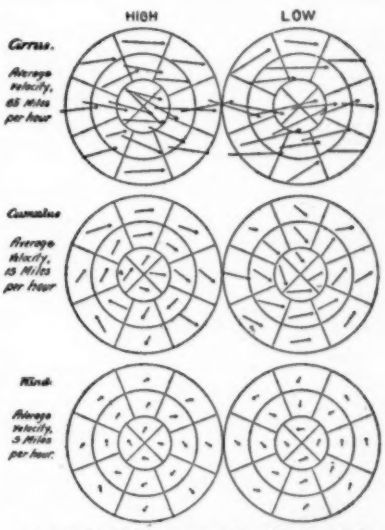

CHART 5. Direction and velocity of the motions of the air in the cirrus (6 miles high), the cumulus (1 mile high) and on the surface (wind).

tinctly seen, and in the cumulus it predominates. The length of the arrows shows the relative velocity, which is seventy miles per hour in the cirrus, on the average, forty-five miles in the alto- and strato-cumulus, fifteen in the cumulus and six on the ground. Compare Chart 1. The total motion of the upper air is made up of two parts, a rapid and quite steady eastward drift, and a local or secondary circular movement; these two combine and make up the observed circulation that actually exists. They are due to different causes, the first to the fact that the tropics are warmer than the polar regions, and that the earth is rotating on its axis; and the second to the fact that these two different temperatures seek to combine into an equilibrium by means of an interchange of heat through the air currents, especially in the strata from one to three miles above the ground. These counter currents flow against each other, and at or along their junction they produce rotations and whirl up cyclones or local storms. This is the law in the temperate latitudes from 30° to 50°; another law prevails in the tropics and possibly in the polar zones, though these belts have not yet been suitably studied. These counter currents can be readily seen on Chart 4 in the arrows drawn with a broken line, where a great stream flows from the northwest and recurves along the Mississippi Valley, while a second stream arising in the Gulf of Mexico flows northward, and recurves to the westward over the Lake Region. Along the edges of these currents is the place for rainfall, for the formation of cold waves, the production of tornadoes and thunderstorms. One can readily judge from relative lengths of the arrows on Chart 5 to what a disadvantage the forecaster is put in attempting to anticipate the probable storm action by using only the small arrows on the surface. He ought to have access to those of the higher strata as well, and this is the reason for the special efforts which have been made by the Weather Bureau through the cloud observations and the kite ascensions to in some measure overcome this defect. It is hoped that by means of nephoscopes and the necessary study of the facts already obtained to be able to make at least three simultaneous daily weather maps, one on the sea level, one on the 3,500-foot plane, and one on the 10,000-foot plane. This will give us three sections through each storm instead of one as at present. The forthcoming report of the Weather Bureau on the Barometry of the United States and Canada contains a discussion of these data and the necessary reduction tables for all the stations of the service. The sea level reduction tables were put in operation on January 1, 1902, and the tables for the other planes are nearly ready for use. There is reason for expecting that a good measure of success will attend these efforts to obtain practical results of considerable advantage in the art of forecasting.

CONTRIBUTIONS TO BIOLOGY FROM INVESTIGATIONS ON THE BREEDING SALMON.

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IN science as in history, it often happens that facts bare and dry in themselves are infused with a sympathetic human interest, when viewed as events in the lives of men. Such an interest, focused in a single devoted investigator, and intensified by the pathos of his death, attaches to the name of Friedrich Miescher, late professor of physiology in Basel. In 1895 by more than twenty years of laborious investigation, he had brought to a successful conclusion one of the most brilliant and important researches ever attempted in biological chemistry. Up to that time few and incomplete reports of these results had appeared in print, the personal modesty and scientific caution of the investigator tempting him to delay publication. So it happened that the great mass of his researches was recorded in notes which only their author could decipher, when Miescher was seized by a mortal disease, and after a lingering illness, with the chapters describing his work completed in his brain, but with no strength to transfer them to paper, he died in the bitterness of a life work completed, but unpublished.

It may indeed be doubted whether the value of Miescher's work would have received full recognition twenty years ago, since many of his investigations then completed bear on problems which had formed themselves in the minds of few biologists of that time. To-day, however, these problems are of universal interest. The recent publication of two volumes* containing the few papers which Miescher had published, both on the salmon and on other subjects (which by themselves would entitle him to a high place among physiologists), together with extracts from his letters to his colleagues describing his work, and such of his notes as could be utilized, dates Miescher's work from the present time rather than the period of its performance.

For a proper understanding of the extraordinary tissue changes which he discovered in the breeding salmon, Miescher found it necessary to investigate fully the life and habits of these fish during their sojourn in fresh water. Of this subject little more was known than such practical knowledge as fishermen had developed. The position of Basel close to the head waters of the Rhine, the breeding ground of the

* Friedrich Miescher, 'Histochemische und Physiologische Arbeiten'; Leipzig, F. C. W. Vogel, 1897.

salmon, gave Miescher peculiar opportunities for this investigation. The salmon spawn during the latter half of November and the early part of December, or just before the shallows of the lakes and streams, where the eggs are deposited, are frozen over. These eggs are hatched by the warmth of the next spring. During the following year the young salmon live in the lakes and streams, and when a year old and from seven to nine centimeters in length swim down the river and out to sea. These facts were easily established. To determine the probable period of the salmons' return to fresh water was more difficult. By measurements of more than two thousand of the fish caught at Basel, together with statistics of those taken in the lower reaches of the Rhine and in other rivers of Germany and Sweden, Miescher found that the greater number both of males and females could be classed under one or other of three sizes. Contrary to what might have been expected the most numerous of these classes is that of the largest and oldest fish, while the least numerous is that of the small 'St. Jacobs' salmon. Unless it be supposed that some of the younger fish go to other rivers, which is unlikely, it is evident that not all the salmon of the proper age participate in every migration to fresh water. These considerations and others, based on the probable rate of growth of the fish, led to the conclusion that from two to three years after entering the ocean, many of the males and a few of the females make their first journey up the river to spawn. This accomplished, the fish return to salt water for another period of about three years. Then occurs a second migration to fresh water by a large proportion of both sexes. The males of this migration average seventy centimeters in length, the females seventy-six centimeters. Probably all of the salmon that have survived the dangers of marine life unite in the third migration. The average males of this age have attained a length of eighty-two centimeters, the females ninety centimeters. These differences in size Miescher regarded as the result of another period of life and growth in the ocean, between the second and third migrations, of at least two years. As only a few salmon of ninety-eight to a hundred centimeters length are taken, and these are all males, it is probable that the females as a rule make only two journeys to the spawning grounds during their lives, while the males ascend the river three or even four times. Within considerable limits of error the probable age of the largest salmon taken in the Rhine is therefore fourteen years.

By a careful comparison of the statistics of the number of the salmon taken in Holland and at Basel, Miescher found that any marked increase in the catch in the lower reaches of the river was regularly followed, after an interval of eight or nine weeks, by the appearance of an unusually large number of the fish in Switzerland. Basel is five hundred miles from the mouth of the Rhine, and if the average current

were only twenty-five miles a day, the fish must make their way through two thousand miles of water. In fact, however, the Rhine is throughout much of its course a swift flowing river, leaving Switzerland at a speed of four or five miles an hour; and the spawning grounds of the salmon lie above the falls and rapids south of Basel. Indeed even these considerations can scarcely be taken as a measure of the physical exertions of the salmon, since the swifter the current the greater becomes their activity. The heaviest runs of the salmon occur during June and July, although many fish whose condition shows them fresh from the sea are taken at Basel even during January. All these fish remain near the head of the river through the spawning season, and in the following December unite in a headlong rush back to salt water. The average duration of their stay in the Rhine is therefore from six to nine months, while in some cases as many as fifteen months must elapse from the day the salmon enter the mouth of the river until their return to the sea.

In view of these facts it would seem almost beyond belief, had not Miescher established it by absolutely complete demonstration, that the salmon never feed in fresh water. From the day they leave salt water until they return to it they maintain an absolutely unbroken fast. Careful examination of more than three hundred fish caught at Basel at all periods of the year, and of many taken in the lower reaches of the river just after the fish had left the sea, showed that not only was the alimentary canal empty of all food material, but the digestive apparatus was in no condition to handle nutriment even if offered it. The gastric mucosa was in a more or less desquamated condition, and alkaline in reaction. The gall bladder was empty, and the pancreas shrunken. Only two exceptions were noted, and these more apparent than real. In the stomach of one fish was found a large winged insect—quite undigested; in another a minnow—only partially digested. Of the latter case, however, Miescher records that the fish was caught near Basel in January, long after the spawning season, and was so extremely emaciated as to suggest that it must have been prevented in some way from escaping back to the sea.

The development of the genitalia (or sexual glands), occurring almost wholly after the salmon have entered fresh water, becomes of the greatest interest in the light of these observations; for the material built up in these organs must be drawn from the other tissues of the animal itself. To the problems involved in these tissue changes, as well as to those resulting from the expenditure of energy by the fish in their long journey up stream, Miescher devoted himself especially. His examinations and analyses of the salmon caught in the lower reaches of the Rhine at all periods of the year, and of those taken at Basel from January to May, show that the fish on their way up stream

are always in a well nourished condition. The intestines are surrounded by masses of fat; the muscles in all parts of the body are full and firm, and exhibit innumerable globules of oil within and between the fibers. The sexes are practically indistinguishable. The genitalia amount to only three-tenths of one per cent. of the weight of the animals. During the months from May to December a gradual but steady change takes place. The jaws of the males develop a beak three to five centimeters in length. The skin of both sexes changes color, losing much of its luster, and becomes loose. The fat about the intestines disappears first; then that contained in the muscles. Certain muscles of the back, which are less important in swimming, diminish to nearly half their original size; and their content of solids to an even greater extent. The muscles most important in swimming, however, are maintained in full vigor; and even in those drawn upon, it is significant that no loss of structure occurs; for on the salmon's return to the sea, this material can be replaced without a reconstruction of the tissue. Just before spawning, the average weight of both sexes is ten per cent. less than that of fish of equal length (eliminating the difference due to the growth of the jaws of the male) caught in May. In contrast with these changes is the growth of the genitalia. The testes or spermaries of the 'ripe' males amount to as much as six per cent. of their body weight, and the ovaries or roe of the females to twenty or even twenty-five per cent., and contain thirty per cent. or more of the total solids of the fish.

While the available information on the subject is as yet by no means so complete as is desirable, on the whole it indicates that the habits of the salmon in other parts of the world, and of other species, are at least similar to those of the Rhine. It is the belief of many of the guides in Maine and New Brunswick that the salmon in their streams do not feed after leaving salt water, and that the 'fly' used to catch them must appeal to their curiosity rather than to their appetite.* The salmon in the rivers of Scotland certainly resemble

* During the past summer Dr. C. W. Green, of the University of Missouri, has been carrying out investigations in conjunction with the U. S. Fish Commission on the salmon of the rivers of the Pacific coast. As these researches have not yet been published the writer is personally indebted to Dr. Green for this statement: "Concerning the question whether or not the 'King' salmon takes food in its run up the Sacramento, I have reached the tentative conclusion that it does not, in fact can not. Every salmon examined by me at the U. S. Fish Hatchery at Baird, Cal., and I examined many, not only had no food in the stomach and intestine but these organs were so much atrophied that only the smallest object could have been swallowed. Salmon a meter in length have an intestine not larger than a small lead pencil, and the stomach is reduced to less than seven centimeters in length. On the other hand in the stomach of one salmon taken direct from salt water at Monterey I counted eighteen squid and several small fish."

closely those of the Rhine according to a recent and very thorough investigation* by the Fishery Board of that country. The salmon in the rivers of Alaska, however, acccording to the report upon the subject by the United States Fish Commission,† exhibit certain differences which are significant of the physiological purpose of the habits and tissue changes in the breeding salmon. The principal runs of these salmon from the sea to their spawning grounds occur after the ice has broken up, and through a great part of the brief Alaskan summer. The number of fish swimming up stream at such times is so enormous that at places the current is almost choked by the struggling mass. A man wading through the shallows can kick the salmon out upon the shore by scores. The distances which these salmon must ascend is much less than in the Rhine—often only a few miles. Yet the difficulties overcome in struggling over shoals, leaping up waterfalls, and in attempting to pass the barriers of heavy timber recently erected by the canneries, are enormous. During this journey the males develop formidable looking beaks, and the genitalia grow to a size even greater perhaps than do those of the Rhine salmon—although exact figures are not available. At the same time both sexes become emaciated to an extreme degree, all the muscles and organs of the body being drawn upon apparently to supply material to the genitalia. It is certain that the fish do not feed after leaving salt water; indeed it is doubtful whether the beaks of the males would allow it even if they wished. But all the Alaska salmon—of which there are several species—differ from those of the Rhine in one respect. No adult salmon has ever been seen swimming down stream, and those which are washed down by the current die after reaching salt water. The greater number after spawning remain near the spot where the eggs are deposited, driving off intruding salmon that would disturb their nests, and marauding trout that would devour their eggs, until overcome by starvation and the exhaustion entailed by their journey and tissue changes, they die. They afford a striking example certainly of the sacrifice of the individual to the good—or the only 'good' that Nature seems to recognize—the perpetuation of the species; and this example is none the less striking because it can scarcely be supposed that these fish have any consciousness of the object for which they thus struggle and die.

The reason for these habits and tissue changes is probably to be found in the advantages which they confer upon the salmon in the

* Report of the Scottish Fishery Board on the Investigations on the Life History of the Salmon in Fresh Water, from the Research Laboratory of the Royal College of Physicians of Edinburgh; Edited by D. Noël Paton, M.D., 1898.

† *Bulletin of the U. S. Fish Commission*, Volume XVIII., 1898.

struggle for existence. The risks to which the eggs are exposed are indeed enormous. Many fail of fertilization; many are devoured or otherwise destroyed. Nor do the dangers to which the salmon are subject end with their hatching. Even if the growing fish escape the voracity of the trout in their natal streams, a host of enemies await them in the ocean. If the number of salmon from year to year remains fairly constant, it is evident that the chances for any one egg surviving to become a mature fish, to replace one of its parents and in turn have offspring, would be represented by two, while the chances of destruction would equal nearly the total number of eggs produced by the female, which amount to many thousand. Yet compared to the dangers which a deep-sea fish like the cod must escape, the hatching and early life of the salmon in the lakes and streams probably offer great advantages. Were the salmon to remain in fresh water, however, where the food supply is limited, their numbers would be at least as limited as are the trout. The same explanation probably holds good for their fasting in fresh water. Were they to feed during the spawning season they would leave nothing for the newly hatched fish,—and indeed the spawn of the preceding year and their own eggs would form, as in the case of other fish, a large part of their diet.

In the salmon nature offers to science, on a scale far exceeding the resources of any laboratory, an experiment in the metabolism of hunger —a demonstration that the energy liberated within the animal body comes not directly from the combustion of the carbonaceous substances of the food, as the energy of a steam engine from its fuel, but from the breaking down of the tissues themselves. Furthermore the conditions are reduced to their simplest terms. In the warm-blooded animals the maintenance of a temperature many degrees above their surroundings, necessitates a continual drain on the potential energy stored in their tissues. In the cold-blooded salmon, on the other hand, lying quietly, for weeks or months together, between the stones on the bottom of the Rhine, the processes of oxidation sink to a minimum, involving little else than the movements of the gills and the beating of the heart. Thus the energy latent in the fats, carbohydrates and albuminous substances, which the fish brings from the sea, is utilized almost wholly in the contractions of the muscles; and within the limits of the dynamic efficiency of these tissues this force is expended in the mechanical work of swimming. For physiologists the especial importance of this experiment lies in its bearing on the recent revival, in modified form, of the theory of Liebig, that the heat of the body is maintained by a combustion of the fats, but that the albuminous substances or proteids are the source of muscular work. Unfortunately the data upon this subject collected by Miescher are only partially available. The conclusions, however, at which he arrived, are sup-

ported by the thorough investigation of Dr. Noël Paton and his co-workers of the Scottish Fishery Board on the salmon of their rivers. They have determined the amount of the various fuel materials which disappear from the bodies of the salmon during their journey up stream. For this purpose they have analyzed all the tissues and organs of numerous salmon taken from the estuaries in the spring and early summer, just as the fish were starting up the rivers. They also found the amount of fat and albuminous material remaining in the tissues of the fish taken from the head waters of the rivers, a month or so later. By calculating from the numerical results of these analyses the equivalent figures for a fish of 'standard length'—arbitrarily taken at one meter—a fairly accurate basis of comparison was obtained. On this basis the difference in the composition of the tissues of the fish of the estuaries, and those of the head waters, reveals the number of grams of fat and albuminous material which the journey up stream costs the fish. The results show that, varying with the length of their journey—which in no case approaches the distance up the Rhine—the swiftness of the current overcome, and the other exertions necessary, the salmon in passing from the estuaries to the head waters, expend three hundred to six hundred grams of fat, and only sixty to a hundred and twenty grams of albuminous material. In the animal body the combustion of the fats and sugars is complete. They leave the system in the form of carbonic acid and water, after liberating within the tissues precisely that amount of energy which they would yield as heat, if burned in a perfect lamp or the most accurately constructed calorimeter. For the albuminous substances the combustion is less complete; but the amount of energy which comes from each gram decomposed within the body is determinable with no less accuracy than for the fats. To find the energy which the salmon expend in the ascent of the Scottish rivers, it is only necessary, therefore, to multiply the amount of fuel material expended by the number of calories which one gram of fat or albuminous material yields in a calorimeter. Thus it is found that the same six hundred grams of fat and one hundred and twenty grams of proteid, which the journey up the longer rivers costs the salmon, would heat sixty-five liters of water from the freezing point to boiling, or, to express the same amount in terms of mechanical work—would, if theoretical conditions in this regard were attainable, lift fourteen kilos (the weight of the 'standard fish' of the Scottish investigations) to the height of a hundred and eighty kilometers. But it must be borne in mind that the dynamic efficiency of few engines devised by man exceeds fifteen per cent.; and the investigations of physiologists have shown that the contracting muscles develop an efficiency only five to ten per cent. greater. From such data as these, together with the rate of flow of rivers, their length, and the time

consumed by the salmon in accomplishing the distance, it would be easy to reach fairly exact conclusions in terms of distance traveled, weights transported and fuel expended by the salmon, and to compare these results with those accomplished by a steamship; or to calculate the resistance of the water overcome by the salmon, and from this compare the relative advantages of the 'lines' of a salmon and those of a racing yacht. There can be little doubt that in the first case the advantages would be heavily on the side of the salmon, and that the yacht would show little if any superiority. But leaving aside such theoretical considerations—for which, it is only just to say, Dr. Noël Paton and his coworkers are in no way responsible—the investigations on the Scottish salmon show that eighty to ninety per cent. of the energy liberated by them in the muscular work of swimming is derived from the fats. The hungering salmon, like a hungering man or dog, reduces to a minimum the waste of protoplasm—that peculiar jelly of albuminous substances which constitutes the chemical framework and essential mechanism of the living cells of the body. In the salmon ascending a river, as in a man ascending a mountain, the energy liberated in the work done is supplied by a vigorous oxidation, and this is evidenced by an increased absorption of oxygen and excretion of carbonic acid. The elimination of nitrogenous substances from the waste of the tissue proteids is, however, only slightly increased.

No less interesting are the processes by which the genitalia develop, since they afford an example of constructive activity almost without parallel among animals; processes so characteristic of plants, on the contrary, that they were long supposed to exhibit the generic differences in the vital mechanism in the plant and animal kingdoms. Modern research has, indeed, shown that these great apparent differences are matters of degree, not kind. Plants can not now be considered as devoted solely to absorbing carbonic acid, and by means of the heat and light of the sun synthesizing carbonaceous material. They can, and when need arises, they do draw on their store of fuel, exhale carbonic acid, and even liberate measurable quantities of heat. On the other hand, physiologists have come to admit that the cells of the animal body, although wholly dependent on the vegetable kingdom for their materials and energy, yet possess wide powers of transforming the food substances to their needs. Uncertainty has, however, attended the efforts of the investigator of metabolism in man and the higher animals. Generally when the subject of the experiment fasts, growth stops. If on the other hand the subject is fed, the origin of the substances shown to appear or increase in any tissue—for instance the fats—may be assigned with almost equal chances to any one of the constituents of the food, or to a transportation from other tissues of the body itself. In the salmon, on the contrary, the conditions are of extreme simplicity

and clearness. The constituents of the genitalia are essentially different chemical compounds from the substances of the muscles out of which they are manufactured; yet the fact that their formation takes place wholly during the period of the animals' fast, leaves no other source for them. In the synthesis of these complex organic substances, the phosphorus—to mention only one element—can be traced with certainty back to the simple phosphates stored in the muscles of the salmon of the estuaries.

The mechanism by which this material is transported and transformed was the subject of much careful investigation by Miescher. He noted a marked increase in the functional activity of the spleen—an organ as enigmatic in the salmon as in man. He observed also a decrease in the blood supply to those muscles at the expense of which the genitalia grow, and an equal increase to the genitalia themselves. The special significance of these conditions lies in the fact that a very small blood supply, continued through the summer and autumn, would transport many times the amount of material which actually becomes a part of the genitalia. As these organs are not motile, and are apparently the seat of no marked oxidation, their respiratory needs would appear small. Nature, however, follows closely the principle of 'least action'; and Miescher advanced the theory that, aside from its part in respiration, the oxygen brought to the tissues by the blood exercises a tonic influence upon their constructive processes. Thus in the liquefying muscle the lack of oxygen causes a stoppage and reversal of nutrition. The cell contents are absorbed into the blood. In the genitalia on the other hand the excess of oxygen in which the cells are bathed stimulates their nutritional processes, and results in vigorous growth. This view is, of course, a pure hypothesis. Yet it is interesting on account of its close similarity to theories advanced now, a generation later, by pathologists to explain the causes of abnormal growths in the tissues of man.

Important as are the results of the study of the salmon thus far mentioned, none rank in value with Miescher's investigations on the chemical nature of the sperm and ova. These researches were practically the first in which there was an attempt to lay bare the chemical processes involved in fertilization and the formation of the embryo. The clue which Miescher furnished has been followed by others, until to-day we seem to be approaching a determination of the structure of the proteid molecule—the first step necessary to solving the problem of the chemistry of living matter. Modern histology has shown that the fertilization of the ovum, from which the animal body develops, consists essentially in the entrance of the nucleus of the spermatozoon or male cell, and its fusion with the nucleus of the ovum. The nucleus of the spermatozoon must therefore be regarded as the carrier poten-

tially of those characters physical and mental which the individual inherits from its male parent; as the nucleus of the ovum must be for the female parent. In the series of divisions by which the fertilized ovum separates into the cells which form the tissues of the body, the material or chromatin of the fused nuclei is with the utmost exactness divided equally to each, so that every unit of the system receives its share of this chemical endowment. This much the study of structure has taught us. But to the chemist the ultimate explanation of these processes seems to lie in the nature of the chemical substances composing the chromatin. In the salmon the ova and sperm are easily obtainable, and afford the unfertilized eggs and spermatozoa almost free from admixture with other matter. Accordingly the methods which Miescher employed for the separation of the constituents of these cells were simple, yet yielded the material sought in quantity and purity. The nuclei from the sperm proved to be composed mainly of a peculiar compound or series of compounds of the nature of ethereal salts. The acid radical was nucleic acid—a substance previously discovered by Miescher in the white corpuscles of the blood of mammals; the other component was an organic base which he called protamin. To the question as it presented itself to Miescher's mind, whether protamin may be regarded as the essential element in fertilization, the answer must be in the negative. Miescher found that protamin is not present in the sperm of the frog or the testes of a bull; and subsequent investigators have shown that it is absent even in some fishes. Yet in these cases it is apparently replaced, and the same functions performed by another substance of basic character known as histon. Miescher was led by these facts to the view that there is no one substance which can be regarded as the essential element in fertilization; but that the chemical processes involved are probably a series of reactions.

To attempt even an outline of the investigations and discoveries to which Miescher's study of the chemistry of the cell has led, would necessitate reviewing one of the most fertile fields of biological chemistry, and would involve much that is important in pathology as well. It is sufficient here to point out that what has been accomplished is in great measure the ripening fruit of the seed planted by Miescher in the quiet of his laboratory a generation past. In the final solution of the profounder biological problems, these investigations on the salmon and the researches to which they have led will probably be found to have contributed in large measure toward that object, which Miescher in one of his letters—almost the last before his death—expressed in the words—"There remains then this great question to be fought out by the biologists of the future—Is it chemical composition or cell structure to which we must look as the ultimate basis of vital phenomena?"

WHAT IS PHILOSOPHY?

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DURING the first third of the past century the intelligence of the world honored philosophy as the Queen of Science. In Germany, the capital of higher learning, students crowded into the lecture-rooms of the philosophers and accepted their teachings as gospel truths. Everywhere the deepest interest was manifested in the solution of the great problems of life. A powerful longing seized mankind to unravel the world's profoundest mysteries, and this longing, too impetuous to linger over an examination of the facts, satisfied itself in the study and production of metaphysical systems. A suggestive example of the immense influence wielded by the royal science during this epoch is furnished by the experience of Friederich Vischer, who declares that the entire time and energy of his youth were devoted to the interpretation of the world-riddle. "Indeed, it seemed to me in those days," he adds, "that a man had not attained his majority, and ought not, therefore, to be allowed to marry until he had at least dispersed the darkness surrounding the problem of free will and determinism."*

It was the golden age of philosophy, an age, however, which bore within itself the seeds of its own decay. Fichte, Schelling and Hegel, the members of the learned dynasty, defined metaphysics or philosophy as the ideal reconstruction of the universe from certain indisputable principles, the discovery of these principles being, for the most part, dependent on the possession of a special mental genius. Like Spinoza before them, they deduced from premises which they regarded as absolute, conclusions which seemed to them to be necessary. Closing their eyes to the facts, these thinkers trusted in their ability to account for those facts, by showing what would be the unavoidable logical consequences of certain axiomatic first principles. Experience they considered as valueless in this connection; the most that it could do was to *verify* the deductions of philosophy.† Schelling denies to it even this worth; the ideal construction or hypothesis of the thinker needs no such verification; it is self-sufficient, a law unto itself.‡ If the facts do

* Quoted by Volkelt in *Vorträge zur Einführung in die Philosophie der Gegenwart.*

† See Fichte's *Works*, Vol. I., p. 446; Vol. II., p. 359.

‡ Schelling, Vol. V., p. 325.

not square with the results of speculation, so much the worse for the facts. Although Hegel does not wholly depreciate experimental knowledge, he too lays chief stress on the *à priori* method.* Knowledge is boundless in its possibilities; no limit can be set to man's faculty of truth. Basing themselves upon such conceptions as these, Fichte, Schelling and Hegel undertook the construction of an edifice, which though grand and daring in plan and execution, had no foundation on the earth. And when philosophy loses its footing on the ground, it must Antæus-like perish in mid-air.

While the German metaphysicians and their following were proving by all the rules of logic what the world really *ought* to be, the exact sciences were modestly finding out what it actually *was*. The whistle of the locomotive suddenly awakened the speculator from his dreams, and called his attention to the wonderful progress of natural science with its fruitful methods and useful results. A reaction soon set in against Hegelianism, and its star sank. Men grew aweary of fanciful speculations and longed to return from the clouds to the realities of the material world. Railroads were built. Trade and commerce took enormous strides forward, commercial and polytechnical schools were founded. All energies were directed toward the discovery, explanation and application of material laws, and the exact sciences took the place in the public confidence once held by philosophy. Liebig, the great chemist, introduced the laboratory into German universities. Alexander von Humboldt made a reputation for himself as a scientist. Important discoveries were made in France and Germany by physiologists like Müller, Weber, Flourens, Magendie, Lœuret, Longet.† Philosophy lost her crown; despised and forsaken by a world that was now as extreme in its contempt as it had formerly been extravagant in its praise, there was none so poor to do her reverence. The philosopher was described as one speaking of things of which he knew nothing, in words which no one could understand. The mistake lay in identifying all philosophy with a temporary one-sided phase of it. The hue and cry was raised against the persecuted queen. The natural sciences, of course, renounced their allegiance and established an antiphilosophical republic of their own. They deluded themselves into believing in the possibility of excluding philosophical conceptions from their realm; they simply succeeded in introducing loose, illogical notions into their explanations, notions that careful thinkers had long ago rejected as unsatisfactory. Materialism, the simplest and most insufficient solution of the world-problem, became the order of the day.

Conditions like these could not fail to intimidate philosophy. Mis-

* Hegel, Vol. VI., pp. 53 and 78.

† See Lange, *History of Materialism*.

fortune is apt to humble us. It is not strange then that the succeeding generation of philosophers should have been meek, and that even so late as 1874, Wundt should have felt the need of proving that philosophy had a right to exist, and might justly claim a place among the sciences.*

This period of reaction, however, was as transitory as its cause had been. The disturbed pendulum was simply swinging to the other side before resuming its regular movements. The metaphysical need or impulse, as Schopenhauer terms it, is too powerful in man to be permanently suppressed. To ask *why* is one of the noblest functions of the human being; to stifle such inquiry would be equivalent to destroying all intellectual activity. It cannot be stifled. Philosophy is not of an age, but for all time. The last philosopher will die when the last man dies, unless, indeed, that individual happen to be a hopeless idiot. Whoever is capable of thought at all will attempt in some way, be it ever so crude, to explain to himself the world and his place in the world. 'What does it all mean?'† 'What is it all for?' are questions which force themselves upon every intelligent being, and are answered by him according to the light that is in him. (Indeed, his queries themselves are pregnant with entire metaphysical systems.) Nor can the exact sciences themselves operate without metaphysical conceptions. However violently they may protest against metaphysics as though it were the plague itself, they inevitably succumb to the disease, if disease it be. Is the theory of descent utterly free from the taint? Is the atomic theory which Greek philosophy originated in the fourth century B. C. any the less metaphysical because it is promulgated by modern scientists? Is not the attempt to reduce all material facts to their ultimates, matter and force or energy, metaphysical? Is not the theory of the indestructibility of matter and the conservation of energy, as conceived by many, metaphysical? Is not the attempt to refer all energies to one ultimate energy a bold and grand attempt to reach a unity, a first principle, on which all else depends? And what can be more metaphysical than that? In truth, the philosophical tendency to reduce plurality and diversity to unity, to find one common principle that may be able to explain *all* phenomena, prevails in every scientific procedure, because it constitutes the very essence of mental activity. We can not resist the impulse to unify our experiences, we would reach a comprehensive survey of *all* existence, discover the principle or principles which will explain *all* facts. The different sciences dealing with different sets of facts may find ultimates capable of accounting for their facts respectively, but only by ignoring other facts. They give us, as it were,

* Wundt, *Aufgabe der Philosophie.*

† 'Was ist der Sinn der Welt?'—Lotze.

cross-sections of reality while we wish to get a comprehensive view of the whole. Physics may be able to explain *its* facts by assuming the existence of homogeneous atoms and force, but can the chemist understand *his* phenomena without presupposing the *qualitative* difference of such atoms? Can the biologist undertake to interpret life with purely mechanical principles; can he reconcile the purposiveness of organisms with the mechanical theory of causation? Will the psychologist, who deals with states of mind or consciousness, be able to account for the existence of these from the physicist's principles, atoms and motion? A science is needed that will consciously and methodically aim to bring order into this chaos, that will consider *all* the facts, and, if possible, *unify* these facts. It will subject the principles offered by the various sciences to the most critical examination, compare them with one another, point out their inconsistencies where such exist, it will in short, rectify, harmonize and if possible *unify* results. Such a science is philosophy. Its need is apparent. If men are bound to philosophize at all, it is a reasonable demand that they should do the work well. We cannot leave the solution of the greatest problems to chance, to the haphazard methods of persons unskilled in such work, and prejudiced enough to adjust the facts to their theories. Here as everywhere else, he will do the best work who has the best training, and concentrates his entire time and energy upon the field of his choice.

Such reflections as these have brought the modern world back again to philosophy. The philistine is defined as the man without intellectual needs, and the philistine alone sees no need of philosophy. The *great* scientists do not allow their occupation with the details of reality to blunt their vision of the whole. They look up from their microscopes occasionally; they can not rest satisfied with blindly staring at the minutiæ; they aim to understand things by seeing them in their relations to the whole.

The measurement of the time required for a current to pass through the sciatic nerve of a frog will not, taken by itself, make us any the wiser. Mere facts must be made the stepping-stones to something higher. Our age is becoming more fully aware of the need of philosophical study. This is evident from the renewal of the philosophical activity in all departments of knowledge. Protestant theology is striving after a rational explanation of dogmas—heresy trials show that! Catholicism has its philosophy; it accepts the conceptions of Thomas Aquinas, whose source is Aristotle. In jurisprudence, economics, politics, sociology and history the philosophical tendency is manifesting itself. Mathematicians, too, are speculating concerning the nature of number, space and related notions. In the words of Wundt the view is spreading among natural scientists 'that the mere description and combination of the facts of a limited field will no longer suffice, but that it is

the highest aim of the particular branches of natural science to co-operate in obtaining a *comprehensive* conception of nature.'*

A further evidence of the intensification of philosophical activity is offered by the increased sale of philosophical books, the publication of philosophical journals, and the strengthening and establishment of departments of philosophy in our universities. Our own country, though frequently accused of being the most materialistic nation on the globe, is becoming a zealous admirer of philosophy. Our philosophical journals are increasing in number and in circulation, and improving in scientific merit, while our great publishing houses are issuing the works of noted authors of all countries, and rendering them accessible to a wider sphere of students.

We have been discussing in the foregoing the fortunes and nature of philosophy proper, during the immediate past. We identified the term philosophy with *metaphysics*, or the science of first principles. But philosophical study does not occupy itself wholly with metaphysics. That in truth is its very highest and hence latest function. It cannot attempt to offer an explanation of the facts of the world, until it has become acquainted with a large body of these facts. Now the world as a whole presents us with two sets of phenomena, physical and mental, and corresponding to this division we have two classes of sciences, physical or natural science and mental science. The former deal with the manifestations of the external or physical universe, with lifeless and living matter; the latter, with the manifestations of the inner world, with consciousness or mind. The fundamental mental science is called psychology, which analyzes, classifies and explains states of consciousness. On it are based such studies as logic, æsthetics, ethics and the philosophy of religion. Psychology asks such questions as these: What are the nature and conditions of sensation, perception, imagination, memory, conception, emotion, instinct, impulse, attention, volition; all of these states being facts of mind or consciousness. Logic asks: How does the mind act when it reasons, when it reaches sentences that we regard as true? What are the forms or laws or principles of reasoning? What are the methods employed by the scientist in his investigations? What, in short, are the rules of deduction and induction? Æsthetics asks: What in the soul and in objects is it that makes us call things beautiful or ugly, sublime or ridiculous? What makes a production a work of art; what are the laws or principles governing the artistic? Ethics asks: What are the characteristics of morality? Why do we designate one act as right, another as wrong? What forms the criterion or standard with which moral facts are measured? We feel that certain courses of conduct are wrong. What is the nature and origin of this feeling? How is it developed? What,

* Wundt, *Essays*, p. 4.

in short, are the laws or principles governing the moral world, and how do these principles find expression in the life of man? Closely related to psychology and ethics, and furnishing them with a large body of facts, are the social sciences, which consider the thoughts, feelings and volitions of social organisms, or man in society; the ends which such organisms serve, and the means with which such ends are reached. Society, unconsciously or consciously, aims to realize certain ends. What are these ends? How are they realized? We must study the forms which realize them, we must study human customs and institutions, and trace their development. Sociology is the name given to the science which performs this task. These ends cannot be realized without organization, or the state. What are the forms of government, and how do governments realize their ends? The theory of the state, or the science of politics, discusses these questions; it bears the same relation to sociology that ethics bears to psychology. The philosophy of religion investigates those inner facts of human experience which we call religious facts, and is, in so far as it does this, a branch of psychology. But it also studies their external expression, the different forms, and traces the development of positive religions in order to discover from the material thus presented the principles common to all religions. What is the idea which seems to be realizing itself in the history of religion?

The philosopher must pay attention to the fundamental mental sciences, psychology, logic, ethics, æsthetics and the philosophy of religion. These sciences differ from the so-called natural sciences only in their content or subject-matter, not in their general form or methods. All sciences, both physical and mental, occupy themselves with observing phenomena and reducing them to laws, employing all available means of accomplishing this task. But no science restricts itself to a mere registration of laws; it seeks to discover the relations between these laws, to connect them, and to reduce them to their simplest forms. The physicist refers all material manifestations to one underlying principle or force. The biologist finds it impossible to explain *his* facts by means of purely mechanical principles. "How can we reconcile the purposiveness of organisms with the principle of causation?"* The psychologist, again, is brought into contact with another group of facts which the atomic theory cannot account for; mind cannot be explained on a purely materialistic basis. The scientist may be able, by means of mechanical laws, to show how a planetary system was evolved from chaos, but can he account for the existence of the amœba? Can his principles account for the simplest fact of consciousness? To quote Kant's celebrated words: "It seems to me," he declares in his *Theory of the Heavens,* "that, in a certain sense, a man may say without pre-

* Wundt, *Essays*, p. 5.

sumption: *Give me matter and I will build you a world. . . .* But can he make the same boast with reference to the simplest plant or insect? Can he say: *Give me matter and I will explain to you the evolution of a caterpillar?"*

Each science endeavors to reduce the most diverse facts with which it deals to identity, to one underlying principle. Heat, light, sound, electricity are different forms of some underlying force or energy. Are states of consciousness referable to the same force, or must we assume another ultimate, of which both physical and mental facts are the expression, as the monists hold?

All these are problems that are worth considering. The difficulty of solving them and the disagreement existing between the attempts to solve them suggest another problem. The human mind has a tendency to unify, to reduce facts to ultimates, to first principles. What is the value of this tendency as a means of reaching truth? Can we know anything about these things? The instrument of knowledge, the human mind, without which there could be no science at all, is itself a fact which needs to be explained. We evidently employ the same methods in the different branches of knowledge, we explain facts by referring them to their antecedents, simply because this is the function of the mind. But is there no limit to this search for antecedents or causes? What epistemological value has the causal instinct? In fact, what does human knowledge consist in, and how is it possible, as Kant asks? Define its limits, before you set out on the vast sea of speculation. We need a science which will examine the nature and validity of knowledge, a *theory of knowledge.* As Helmholtz declares, no age can with impunity refuse the task of examining the sources of our knowledge and the ground of its validity. The different sciences employ the categories of thinking without investigating their validity. Philosophy must regard with suspicion everything that is not clear as day; it is 'nothing, if not critical.' In his attempt to explain the sensible world, the scientist often has recourse to the suprasensuous. Can we know anything of the suprasensuous or must we confine our efforts to the study of what our senses present to us? Must we accept DuBois-Reymond's verdict? "Concerning the riddles as to what matter and force are, and whether they can think, the natural scientist must once for all decide upon the verdict: *Ignorabimus."** Or shall we protest with Haeckel against the position that there can be invincible barriers to *Naturerkennen.* There are many other problems which suggest themselves to an epistemology, or theory of knowledge.

Such a science not only forms the prelude to the most important part of philosophy, to metaphysics, but also assists the thinker in discover-

* DuBois-Reymond, *Grenzen des Naturerkennens.* Galileo made a similar statement.

ing the inconsistent and premature metaphysical conceptions which stealthily creep into all branches of knowledge. The natural scientist frequently rails against metaphysics in the very words of metaphysics, without knowing that his entire mental activity is based on metaphysical preconditions. Metaphysics is the old man of the sea whom the scientific Sindbad carries on his own shoulders, without, however, feeling the load.

After having studied the limits and validity of human knowledge, the philosopher is ready for the construction of his metaphysical system. He calls to his aid the history of philosophy, which unrolls before him the thoughts of past ages and bids him profit by their experience. The history of philosophy must not be regarded as 'a disconnected succession of arbitrary individual opinions and clever guesses,' it is not a formless aggregate of errors, not a series of unsuccessful attempts to reach truth. It is not a Sisyphean labor, a Penelopean woof. The history of philosophy is a development, an evolution, in which the forms which follow generally show an advance over what precedes. And even if it were a mere catalogue of errors, it would be of service to the metaphysician by pointing out to him the lines of thought that have ended in blind alleys; it would warn him against wasting his energies in fields that have been worked over. The man who knows how a solution can *not* be effected is on the road to knowledge.

A STUDY OF CALMS.

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AMONG the suggestive things which have been noted in the course of a series of studies which I have made in an attempt to discover the influence of the weather upon human conduct, no one has been more interesting or unexpected than the seeming effects of calms. Few people are immune to weather influences, and most of us are in a more or less apologetic mood for our behavior during some meteorological condition. East winds and leaden skies are made scape-goats for many a sin of omission or of commission, but it has not been my observation that conditions of calms were often used in that way.

That they do exert a marked influence upon human activities I hope to demonstrate in this paper. The method is wholly an empirical one. Various records of the occurrence of different abnormalities of human conduct were made use of, and the average daily occurrence of these phenomena for a number of years, compared with their average daily occurrence under definite meteorological conditions. The study was for the city of New York—a fact that must be borne in mind since it has an important bearing on the present problem—and covered a period of twelve years, for every day of which the mean temperature, barometric pressure and humidity, the wind movement, the precipitation and the character of the day were determined and used in the tabulation.

The conditions covered by this problem, the number of data, and their sources are as follows:*

Registration in Public Schools.....	118,020	School records.
Deportment in Public Schools.....	14,020	School records.
Deportment in Penitentiary.....	3,981	Penitentiary records.
Arrests for assaults and battery (males)	36,627	Police records.
Arrests for assaults and battery (females)	3,981	Police records.
Arrests for drunkenness (males).....	44,495	Police records.
Arrests for insanity (males).....	2,467	Police records.

* Fuller studies have been published as follows: 'Conduct and the Weather,' Monograph Supplement, No. 10, *The Psychological Review; The Pedagogical Seminary*, April, 1898; *The Scientific American Supplement*, June 3, 1899; *Science*, August 11, 1899; *Appleton's Popular Science Monthly*, September, 1899; *Educational Review*, February, 1900; *Nature*, February 11, 1900, *Annals of American Academy of Political and Social Science*, October, 1900; Popular Science Monthly, April, 1901; *International Journal of Ethics*, July, 1901.

Arrests for insanity (females)	1,097	Police records.
Suicide	2,946	Police and coroner's records.
Deaths	74,793	Board of health records.
Policemen off duty for sickness	191,137	Police records.
Clerical errors	3,698	Bank records.

The whole number of data considered is 497,262.

The only influences which I wish to discuss in this paper are those of calms. For present purposes I have considered those days as calm, for which the total registration of the anemometer for the twenty-four hours was less than 100 miles. This would mean an average hourly movement of about 4 miles.

To explain more fully the data given above and discuss them: Under 'Registration in the Public Schools' is shown the exact number of single day's attendance which the registers of the schools studied would have shown if none of the pupils had been absent. As a matter of fact 9.2% were regularly absent. These absences were of course distributed throughout the whole school year, and, consequently, throughout all kinds of weather. As would naturally be expected, they varied to a marked degree with the weather. On excessively hot and cold days, on very windy or rainy days, there was a falling off in attendance for reasons that are patent.

The fact of importance from the standpoint of our present study is the falling off on calm days. For the two years studied, the average of absences for days upon which the total movements of the wind was less than 100 miles, was 29%: more than three times the average for all kinds of weather,—an excess of 214% based upon the expected, or average number. Here is something which on *à priori* grounds would scarcely have been looked for. Why were the pupils at home? The most logical answer to that question is, I believe, that they were not well enough to go. That they were suffering from some of the many indispositions to which childhood is subject. Not necessarily measles, nor mumps, nor scarlet fever, but the simple lack of condition which the woman in the next flat understands perfectly when his mother remarks that 'Johnnie was not feeling well this morning, so I kept him home from school.' To be sure, other matters keep the children home on calm days, such as company, funerals and parades, but these things occur just as frequently in other kinds of weather and we can not reasonably suppose that the conditions which we have found are due to them.

The next class of data has to do also with deportment, though not in public schools. It is marked 'Deportment in the Penitentiary,' and is based on the record of the prisoners committed to solitary confinement in the dark cells at the penitentiary on Randall's Island. The number so punished for misdemeanors occurring on calm days was 80% of the daily average for all kinds of weather, showing a deficiency of 20%.

The data for the next five classes of misdemeanors mentioned above were all taken from the blotters in the record room of the New York chief of police. Crime is there classified under 136 different heads, and the arrests for each, recorded for each day. The classes considered by me were studied for periods varying from two to seven years. The figures indicate the total number of arrests made for those periods, by the entire police force of old New York, the present borough of Manhattan.

The terms 'assault and battery' and 'drunkenness' are, I think, self-explanatory. Each arrest for 'insanity' meant that some one had been picked up on the streets in a state of acute mania, or that the police had been called to some house to remove a person in such a condition. In most cases it probably meant an initial attack of the disease, or the beginning of a recurrent attack. Otherwise the person would have been in an asylum, or other authorities than the police would have been appealed to.

To state in the briefest possible manner the seeming influence of calm days upon the distribution of these crimes: The number of males arrested for assault and battery upon such days was 89% of the normal,—by which term I mean the average daily occurrence for the whole period studied; of females for the same crime, 45% of the normal; of males for drunkenness, 77%; of males for insanity, 67%; of females for insanity, 34%. The figures show that there was a deficiency in the occurrence of all these crimes, the magnitude of which may be computed in each case by subtracting the percentage of occurrence from 100%, which is expectancy. In securing the data for suicide, two sources were made use of. In fact it is not solely a study of successful suicide, but of suicidal intent. From the standpoint of our study it is just as valuable a datum from which to work, to know that somebody tried to die at his own hand even though he did not succeed, as to know he was successful in the attempt. An attempt at suicide is a crime and is so recorded in the police records, which were tabulated for a period of five years. This gave us 984 of our data. The remainder were secured by going over some 28,000 death certificates for the same period in the coroner's office. The results showed that but 63% of the normal number of suicides (and unsuccessful attempts) occurred on calm days.

The next class of data given in the list is that of death. It is based upon the record of deaths for all causes in the city for a period of two years. In it we have a notable difference from the crimes and misdemeanors we have been studying, in that the occurrence for calm days was above the normal, being 104%. In this respect it resembles the study of attendance in the public schools, and also the last two classes of data given, those of the 'policemen off duty for sickness' and of

'clerical errors.' Of these two, the data for the first were taken from the annual reports for five years of the chief of police of New York city. It was not there stated that sickness was the cause of absence from duty, but it is safe to assume that it was the usual one. It is, however, rather interesting to note that immediately following Christmas, New Years, and other holidays, an unusual number was laid off, but we may charitably suppose that the weather was excessively deadly in its effects at those times. The tabulation shows that 105%, or 5% in excess of the normal number, were off duty on calm days. This would hardly be more in accordance with our expectation than was the school attendance under such conditions. If perfectly calm days were the most agreeable of all kinds we might suppose that our stalwart guardians of the peace had chosen them for picnics, but gentle breezes are generally accepted as being more delectable than dead calms, and we must look for some other causes for the absence of bluecoats under the latter conditions.

The last class of data given, that having to do with 'clerical errors,' was studied as a make-shift. I wished to determine the influence of different weather conditions upon the intellectual as well as educational states of man, and to that end sought long and earnestly for school records which showed a daily marking of class work, but without success. If any teacher who may read this has such, I should be very grateful to him if they could be placed in my hands. While wondering what other records might be made to supply the lack, I came across the statement that in the Bank of England certain sets of books, an error in which would prove cumulative and produce disastrous results later on, were never worked upon during some kinds of weather, especially London fogs, as it had been proved that clerical errors were much more frequent at such times.

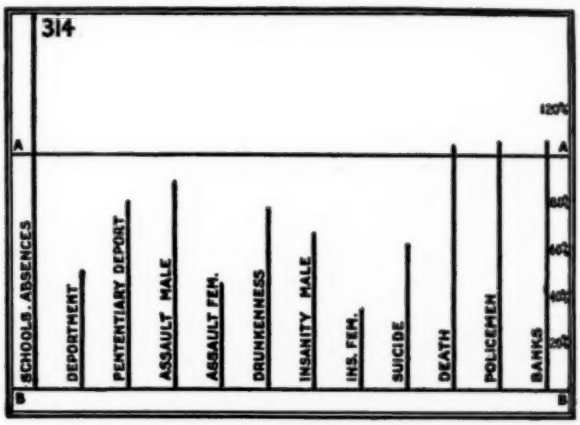
Following the clue here given I gained access to the books of some of the largest banks in the Wall Street district, with the result that in the records for two years, the number of errors stated were found and tabulated with reference to their daily occurrence. The results showed 104% of the normal, or an excess of 4% for the calm days.

To state in a sentence the occurrence of data of all these classes under the condition of calm: absence from school, death, policemen off duty, and clerical errors were all above the normal, while misdemeanors in school and penitentiary, arrests for assault and battery, drunkenness and insanity, and suicide, were below.

The facts so far given do not show whether the change with an increase in wind was a gradual one or not. As a matter of fact it was not. Had it been so, there would have been less excuse for this paper. The most striking thing about the curves upon which it is based is the sudden change which takes place in the occurrence of nearly all the

TABLE SHOWING PREVALENCE DURING CALMS OF PHENOMENA STUDIED.—ONE HUNDRED PER CENT. EQUALS THE NORMAL OR EXPECTED NUMBER.

Schools; absences	314%	Insanity (male)	67%
Schools; deportment	50%	Insanity (female)	34%
Penitentiary; deportment	80%	Suicide	62%
Assault and battery (male)	89%	Death	104%
Assault and battery (female)	45%	Policemen off duty	105%
Drunkenness (male)	78%	Banks, Errors in	105%



activities (or cessations of activity in the case of death) with a slight increase in atmospheric movement. In the case of arrests for assault and battery and for insanity (both males and females), and of misdeeds in the penitentiary, all of which had shown deficiencies for calms —and some of them very large ones—excesses were shown for wind movements between 100 and 150 miles per day, while misdemeanors in the schools were also above the normal before a movement of 200 miles had been reached. On the other hand, policemen off duty and death, both of which had been excessive in number during calms, took a sudden drop as the wind arose, and showed deficiencies for the next wind group (100–150 miles). Suicide, drunkenness and clerical errors alone showed gradual changes with the wind. The appearance of the curves as a whole is such as to lead me to place calms in a class by themselves as far as wind influences are concerned. High winds seem to have an influence peculiarly their own, gradually merging into that peculiar to moderate and slight movements, but when the aerial stagnation of 100 miles per day or less is reached a sudden change takes place, and certain human phenomena suddenly increase in numbers, while others drop almost to a vanishing point. Which are the ones in excess? Absence from school, absence from police duty, clerical errors and death. But absence from school means sickness, absence from duty the same, clerical errors the same in milder forms, and death the same at its maximum.

To restate: *during calms, those life phenomena which are due to depleted vitality are excessive.* But let us return to those phenomena which were deficient in occurrence during calms. They were misdemeanors in public schools and penitentiaries, cases of assault and battery, insanity, drunkenness and suicide. To analyze each briefly: In the public schools, sins of commission rather than sins of omission are usually the occasion of bad marks in deportment. It is usually the active, energetic boy, the one with vitality to spare who gets the demerits. The anemic youngster may never stand at the head of his class, but he is very likely to delight his fond mamma with a mark of 100 in deportment. If that be so, and I speak with authority upon this point if upon no other, disorder in the school room is an active thing, and an evidence of excessive vitality. With the penitentiary inmate I have had less experience, but upon *à priori* grounds would argue that what is true for the child in question of deportment would not be radically different for the adult. In fact the wardens in charge, upon being questioned on the matter, gave it as their opinion that the prevalence of disorder bore a pretty close relation to physical health, varying directly with it; that order was only preserved through evidence of superior force on their part; that a sick person was always a good one, but that with a return to health conditions were frequently very different. We may then conclude that in the penitentiary misdemeanors are evidences of excessive vitality.

With persons arrested for the crime of assault and battery the same is, I believe, demonstrably true. One might feel like fighting and perhaps more frequently does feel so when possessed of 'that tired feeling' which is the fortune of patent medicine venders, but to *feel* like fighting without doing so, never brought a man before the police judge for the crime which we are considering. There must be both the inclination and the consciousness of strength to back it up before one would be likely to figure in this class of data.

In the case of the next class, that of arrests for insanity, we shall take the word of the psychiatrist that acute mania increases with any condition which tends to augment the output of nervous energy. The daily fluctuations in strength which all have experienced are not so much those of physical, as of nervous energy, if the distinction may be made, and with any having tendencies to mania the results would be those which our records showed.

With the occurrence of drunkenness and of suicide we have seeming contradiction to the belief which I have been attempting to maintain for the other phenomena which were deficient during calms, namely that they were evidences of excessive vitality. To discuss the peculiar problem which each of these presents would take us too far from our present subject, so I will simply refer any who are interested

in following the subject further to papers already published by me on the subject.*

With these possible exceptions we can say: *that during calms those life phenomena which are due to excessive vitality are deficient in number.* If these theses have been sufficiently defended, and figures are not in existence with which to refute them, the next logical question would be, 'Why?'

Two hypotheses may, I believe, be presented in answer. The first is based upon the general facts bearing upon ventilation, and the second upon those of atmospheric electricity. The first would only be applicable to the conditions of large cities—and I will again call attention to the fact that all the data of the present problem were for New York City—while the second would be valid for any spot on the earth's surface. In discussing the first I would call attention to the fact that combustion of any sort, whether within the lungs of animal organisms or in the ordinary processes of burning, depletes the air of its oxygen and surcharges it with carbonic acid gas. If the normal proportions of oxygen are to be maintained in the immediate vicinity of such combustion, fresh air must by some means be brought in to take the place of that, the normal mixture of which has been disturbed. We are quite familiar with these facts in their bearing upon the ventilation of buildings, but there is no difference except that of magnitude between a building in which the air is being robbed of its oxygen through combustion, and a city in which the same process is going on.

Three million animal organisms (not all human) and half as many more fires, all without adequate vegetable organisms to reverse the process should, we would argue, make tremendous inroads upon the atmospheric stock of oxygen. That this is true has been demonstrated by Dr. J. B. Cohen in an article appearing in the *Smithsonian Reports* for 1895, p. 573.. He there shows that the proportion of carbonic acid gas varies to a very marked degree in the center of the city of Manchester, England; that the variation extends from the normal amount at times, to more than four times that amount at others, the average being nearly three times the normal. Although he makes no reference to the fact, it is, I believe, safe to assume that these variations bear a fixed relation to wind movements. Certainly when the wind was very violent, no considerable difference could exist between the composition of the atmosphere in a great center of population and in the surrounding country where the normal mixture of gases would be found. It is safe also to assume that what was true for Manchester would be for New York City, and to assume at least as a working hypothesis that

* 'Drunkenness and the Weather,' *Annals of the American Society of Political and Social Science*, November, 1900; 'Suicide and the Weather,' POPULAR SCIENCE MONTHLY, April, 1901.

during calms the atmosphere for that city contains an excess of carbonic acid gas and a consequent deficiency of oxygen. The devitalizing effect of the former gas upon life processes and the importance of the latter to them are facts too well recognized to need discussion here. That they are demonstrated by the conditions stated earlier in this paper I shall maintain until some more tenable hypothesis is brought forward.

Some interesting facts not already alluded to are suggested by this study, and in conclusion I shall mention two of them very briefly.

First, there would seem to be reason to infer that the influence of calms upon children is more marked than that upon adults. The basis for this belief is found in the fact that the absentees from school were increased three-fold during their prevalence, while no one of the classes of adults was affected to anything like such an extent.

Second, that women seem to be more sensitive to such influence than men. Evidence of this are to be found in the study of arrests for assault and battery where the sexes were tabulated separately.

In explanation of my own conception of the whole problem of weather influences, I would say, in closing, that we cannot suppose peculiar meteorological conditions to be the immediate cause of many of the abnormalities of conduct which vary with them. I have determined that suicide is much more frequent when the barometer is low than when it is high, yet would not wish to assert that low barometrical conditions ever drove a man to self destruction. The only thing supposable is that during such atmospheric conditions, the general emotional states are of such qualities that other things are more likely to do so.

This would be just as true for any of the other abnormalities of conduct studied. We can on the strength of the whole series of studies claim to have demonstrated that the metabolic processes of life to some extent vary with the weather states, and that these variations in metabolism make themselves evident both through physiological and psychological manifestations. More than this we do not at present claim.

OUR FOREIGN COMMERCE IN 1901.*

BY FREDERIC EMORY,
CHIEF OF THE BUREAU OF FOREIGN COMMERCE.

THE commercial reports of diplomatic and consular officers for the calendar year 1901 record continued growth in the sales of many lines of manufactures from the United States in foreign markets and the increase of the general concern in Europe as to the possible results of our industrial competition. Although the figures of our exports compiled by the Treasury Department show a considerable falling off in the total value of manufactured goods sent abroad, there seems to be a steady and uninterrupted spread in the popularity of what may be termed American novelties all over Europe. By the word 'novelties' are meant not only labor-saving implements and machinery to which most Europeans were strangers, but a great variety of articles of merchandise, such as boots and shoes, leather goods, hats and clothing, rubber goods, furniture and household utensils, hardware and cutlery, canned goods, glassware, clocks and watches, scientific apparatus, electrical supplies, and cotton, silk and woolen textiles—all of which possess distinguishing points of excellence and relative cheapness, new to Europe, which commend them to purchasers there in preference to similar articles of home manufacture. In other words, while the aggregate of our exports of manufactured goods has shrunk, the variety of our sales in Europe is being extended and the territory upon which they are encroaching is being steadily enlarged.

Advances in Austria-Hungary.

A striking example of this is seen in the case of Austria-Hungary, the country in which originated the idea of a European combination against American goods and where the hostility of the industrial forces continues to be most pronounced. Notwithstanding this, the imports from the United States, according to Consul-General Hearst, of Vienna,† are increasing rapidly, although American exporters have not until recently given general attention to that part of Europe, 'which is considerably removed from ports in closest touch with trans-Atlantic commerce.' So formidable is the growth of American imports, in fact, that 'Austrian manufacturers and agriculturists are making

* Extract from the 'Review of the World's Commerce,' introductory to 'Commercial Relations of the United States, 1901' (in press).

† See 'Advance Sheets of Consular Reports,' No. 1193 (November 19, 1901).

an organized effort to stem the inflow.' At a recent conference in Vienna to take measures against American competition, adds Mr. Hurst, 'it was openly acknowledged that the commercial policy of the present time is dictated and controlled by the United States. . . . Instances of the gigantic strides of our American manufacturing industries are cited to show our capability to forge ahead of all competitors in many fields.'

Still Leading in Germany.

In a report upon the commerce and industries of Germany,* Consul-General Mason, of Berlin, says the United States again heads the list of countries selling to that country, with a total of nearly $243,000,000, or 16.9 per cent. of the entire bulk of German imports, although it should be noted that this covers the values of all American products landed on German soil, 'a large percentage of which simply pass through . . . en route to Russia, Austria-Hungary, Switzerland, and Scandinavia.' It may be expected that later returns will show a falling off in German imports, owing to the recent industrial depression which has seriously impaired the purchasing power of the Empire. But in Germany, as in Austria-Hungary, our goods continue to hold their own, and the 'overshadowing competition of the United States' is regarded by German economists as of grave importance to the future of German industry and commerce. "It is recognized by intelligent Germans," adds Mr. Mason, "that in future industrial and trade competitions, that fine composite product of American racial qualities, institutions, and methods, the workingman who thinks, will, in combination with our unequaled resources, turn the scale in favor of the United States."

Supplying Europe with Goods we used to Import.

The same concern is felt in France, in Belgium, in Switzerland, in Great Britain—in other words, in all of the highly developed manufacturing countries of Europe—and it is a most significant fact that even in specialties which were once thought to be exclusively their own, the United States is becoming a more and more formidable competitor. Who would have imagined a few years ago that we would make such rapid progress in the manufacture of silk that we would soon cease buying silks from France, with the exception of highly finished goods, and would actually be exporting silks to that country? Yet this is what has happened. So of tin plate in Wales. At one time it was doubtful whether we could manufacture tin plate profitably, and it was confidently asserted that the Welsh must always control the Ameri-

* Printed in 'Advance Sheets of Consular Reports,' No. 1185 (November 9, 1901).

can trade. But we now manufacture all the tin plate we need, and the Welsh have recently imported tin bars from us.

There are, indeed, surprisingly few of the articles which used to be obtained exclusively abroad that are not now produced in the United States. The woolen as well as the silk industry of France and the hosiery industry of Germany are said to be suffering severely from our competition, and the Bohemian glass industry is feeling the effect of the increase of glass manufacture in the United States. Our cottons are steadily gaining in taste and finish, and are now sold in England in competition with the Manchester product. Says the Leipziger *Tageblatt* of April 10, 1901: "Even in fancy articles, in which the European market has set the styles for the entire world, the American manufacturers are beginning to compete with the European. British calico prints are also already receiving competition from America. As we hear, travelers of a well-known American house have offered American cotton stuffs in England with much success, and the London authorities declare them to be tasteful and worth their price." A New York company manufacturing cotton stuffs intends to found a Paris house which shall introduce its fancy woven stuffs for women's dresses, and trimmed women's hats are being exported from the United States to Europe. "The reversible cloths which are made in the United States," said Consul Sawter, of Glauchau, in a report sent in 1900, "are now the style in high-priced goods in the German capital." In agriculture, as in manufactures, we are constantly widening the sphere of our production. The orange and lemon growers of southern Europe are feeling the effect of California's competition. "It is ridiculous," says a Spanish newspaper,* "to think that fruits and vegetables raised on the slopes of the distant Pacific should compete at the very doors of Spain with those produced in this country. . . . Shall we live to see American oranges on the Valencia market itself?" We are producing our own raisins, our prunes, our wines, our olive oil, and are sending them abroad. California prunes now compete in Europe with Bosnian prunes, once a staple export to New York.

In the busy manufacturing district of Liège, Belgium, according to the annual report of Consul Winslow, more American goods are consumed than ever before, in spite of business depression. Our sales in general, says Mr. Winslow, have doubled in the past three years, and it is now common to see articles marked 'Americaine' in the shop windows. Spanish journals complain that steel rails are imported from the United States, notwithstanding the production of iron is one of the important industries of Spain. Vice-Consul Wood, of Madrid, says our goods are to be seen everywhere, and include such American

* 'Advance Sheets,' No. 1043.

specialties as hair-clipping machines, dental supplies, typewriters, electric motors, etc.

Decline in Exports of Manufactures.

The people of Europe, it may be assumed, therefore, are not less but more favorably inclined to goods of American origin, and the falling off in our exports, so far as they are concerned, is to be attributed to temporary causes, such as business depression, reducing their purchasing power, with the natural result of falling prices, or to discrimination against our products. The reduction is also found to be due, in part, to the elimination of the Hawaiian Islands and Porto Rico from the Treasury tables of exports to foreign countries, and to trade conditions in the United States, such as those affecting the exports of copper, which have checked the outflow of manufactured goods.

The Treasury statement of imports and exports of the United States for the calendar year 1901 (subject to revision) shows that the total imports amounted to $880,421,056, an increase of $51,271,342 over the year 1900; and that the total exports were $1,465,380,919, a falling off of $12,565,194 compared with the previous year. The exports of manufactures amounted to $395,144,030, against $441,406,942 during the same period of 1900—a falling off of $46,262,912. The percentage of manufactures in the total of exports declined from 30.38 in 1900 to 27.48 in 1901. On the other hand, the exports of agricultural products rose in value from $904,655,411 in 1900 to $940,246,488 in 1901—a gain of $35,591,077, thus largely offsetting the loss in manufactures. The percentage increased from 62.26 to 65.38. The decline in the exports of copper, not including ore, amounted to $24,007,711; and in manufactures of iron and steel, to $27,093,683.

Has Expansion been checked?

Notwithstanding the continued spread of our goods in Europe, and the deductions to be made from the Treasury figures on the score of accidental or natural causes of decline in manufactured exports, it is evident that the 'American invasion' of Europe has ceased, for the time being, to be of the sweeping character that distinguished it at first as an economic phenomenon. Our advantages in industrial competition in the abundance and cheapness of raw material and fuel, in the superior efficiency of our skilled labor, in the unexampled fecundity of our people in the invention of labor-saving machinery, and the advances we are constantly making in economies of production are still the subject of much anxious speculation in the great industrial centers of Europe; but there are some foreign observers who are encouraged by recent developments to hope that conditions may be more

nearly equalized by the substitution of new processes and improved machinery modeled on our own and the adoption of legislative measures aimed especially at our goods. It was pointed out in the 'Review of the World's Commerce' a year ago* that, in the reports of the consular officers for 1900, there ran 'along with a common note of satisfaction, a warning, here and there, of a more strenuous competition, which, in the end, may counterbalance our superior advantages to a considerable extent and check our progress in the world's markets, unless we equip ourselves in the meantime for the ultimate phases of the struggle.' As yet, it cannot be said that Europe has made any sensible progress, in actual performance, toward more strenuous competition. The measures adopted thus far are almost wholly tentative or preparatory, and it may be that those which involve restrictive legislation will be abandoned if the United States should consent to modify its tariff policy and permit the importation of a larger volume of European goods in return for similar concessions.

An English View of American Competition.

Upon the other hand, the decline in our exports of manufactures is taken in some quarters to indicate a subsidence in the aggressiveness and force of our competition. The London *Times* of January 7, 1902, in a careful review of our material progress in 1901, inclines to the view that we may have reached 'the top of the wave of commercial prosperity' and that the danger apprehended from the United States of 'aggressive economic interference with other countries' is not so serious as it was generally thought to be in the earlier stages of our expansion. Great as has been the real commercial and industrial success of the United States during the last two or three years, says the *Times*, "we are convinced that it is insufficient to warrant the view of its economic results taken either by sanguine Americans or by timid Europeans. The United States are not, as many Americans and some foreigners seem to imagine, exempt from the laws of nature. There are people who are so fascinated by great relative magnitude that they are unable to distinguish between it and infinity. Their judgment becomes, so to speak, polarized by the too intense contemplation of great but variable economic forces, just as a compass needle is disturbed by the proximity of a relatively large mass of iron, and their minds become incapable of receiving impressions from evidence that the really permanent economic forces are not dead or even sleeping. Now, there have been several pieces of evidence during the past year that the economic situation in the United States is not altogether so good as it appears to those who merely look at and discuss the surface,

* 'Review of the World's Commerce for 1900.'

whether from habit or because they have reasons for not wishing the public to look any deeper." In support of its assertions, the *Times* endeavors to show that the continued expansion of traffic receipts of American railroads loses much of its apparent significance when the fact is considered that it is not a new thing, but 'had been going on for a long time before the end of 1900'; that the sanguine prediction that, in a very few years, New York would be the monetary center of the world, based upon the theory that the United States was becoming a creditor instead of a debtor nation and was lending money to Europe instead of borrowing, is not being realized; that 'America has gone, for the time being, quite as far in the direction of employing her resources and credit as is safe, and possibly a little farther'; and that "the American public has never recovered from the fright it got in May last, in spite of every endeavor on the part of the leaders of the business world to allay the apprehension created by the panic, and to encourage a belief in the strength of the bond which 'community of interest' was supposed to have established among the able and ambitious men who govern the great business corporations of the United States."

Our Industrial Efficiency Undiminished.

Whatever be the force of these conclusions, they do not necessarily detract from the efficiency of the United States as a competitive force in the world's markets, for they do not in any way affect the advantages peculiar to us as an industrial nation, and if they did, they would be offset by drawbacks such as insufficient supplies of raw material and fuel under which the other manufacturing countries must, in the very nature of things, continue to labor. Moreover, it will probably be a long time before the conservative, slow-moving industrial forces of Europe will adapt themselves to the novel requirements which American ingenuity and enterprise have created. Both labor and capital in Europe would seem to have a long and difficult task ahead of them before they shall have approximated to the economics of production which we have mastered.

Alleged Obstruction by British Labor.

The labor conditions in Great Britain especially appear to be such as to seriously embarrass progress there and to give us a broader margin of opportunity in more quickly and more economically meeting the demands of foreign consumers. In a series of articles entitled 'The Crisis in British Industry,' a writer in the London *Times* asserts that the English trades-unions have so hedged about the productive forces of the Kingdom as to greatly diminish output and delay the execution of work. "Thirty years ago, our correspondent states, and we believe accurately," says the *Times* editorially, "a bricklayer

would lay 1,000 or 1,200 bricks in a day. In America, we are given to understand, the figure is even higher. Now, by an unwritten but mercilessly enforced trades-union law, a man must not lay more than 400, and if he works for the London County Council—that is to say, for the ratepayers—he must not lay more than 330. Our correspondent quotes a case of a building put up for the school board in which the average output of the bricklayers was 70 bricks a day. Yet these are men receiving the highest current rate of wages, a rate very greatly in excess of what was paid when 1,000 bricks were laid per day. This is typical of what goes on in every trade, though it may not always be so easy to give exact figures."

The United States consul at Liverpool, Mr. Boyle, in his annual report for 1901,* gives a most interesting description of the lengths to which this restrictive policy is carried. "The charge is made," he says, "that there is a general disposition on the part of British workingmen to obstruct as much as possible the use of labor-saving machinery, and to limit its output whenever the employers add machinery to their plant; and also that, in certain trades, the rule is 'one man, one machine,' whereas in America one man will attend to two or three machines. It is furthermore charged that there is an increasing disposition on the part of British workingmen to shirk work, and to use all expedients to perform as little labor as possible during the hours for which they are paid. These charges are made with great particularity against trades-unionists. There is, it is to be noted, a growing tendency throughout the country to shorten the hours of labor, while at the same time there is an upward movement in wages. As a rule, trades-unionists deny the charge of obstructing the use of labor-saving machinery and limiting the output; and they retort that employers are lacking in enterprise in not fitting up their factories with up-to-date plants. It is undoubtedly true, however, that, speaking generally and quite apart from the question of trades-unionism, English manufacturers find it almost impossible to get the same amount of product from machines as is obtained in America. There are two reasons that account for this, independent of any agreement, expressed or implied, on the part of trades-unionists to limit the output. The first reason is that, as a rule, the British workman is not as adaptable as the American workman—he does not so readily get command of new appliances as the American workman; and the second is that it is not the custom of the country for an Englishman, whether mechanic, clerk or laborer, to work as hard as an American." In Consul Boyle's opinion, 'trades-unionism has an influence in England far beyond what it has in the United States'; but he adds: 'It is but just to say that there is greater

* See 'Advance Sheets of Consular Reports,' No. 1222 (December 24, 1901).

need of trades-unions in this country than in America. Undoubtedly, English trades-unions have brought about great reforms in the condition of factories, as to the hours of labor, in regard to the employment of children, etc.; and there are indications that the alleged restrictive policy of trades-unions, express or implied, is gradually being modified."

American Workingmen promoting Expansion.

Whatever be the merits of the points at issue between employers and organized labor, it is evident that the existing conditions are not only unfavorable to the increase of Great Britain's competitive energy, but actually handicap her in the effort to adapt herself to the industrial exigencies which we have created. The advantage we enjoy in this particular is rendered all the more formidable from what seems to be a growing tendency in the United States toward a more harmonious cooperation between labor and capital, as was strikingly shown in the recent conference of employers and labor leaders in New York which resulted in the creation of a permanent board of conciliation. American workingmen generally, instead of seeking to limit output, strive to increase it, and they find their reward in the cheapening of production, which enables the manufacturer to compete in foreign markets and thus get rid of the surplus beyond the demands of home consumption, with the result of keeping his factory going and giving steady employment to the operatives throughout the year.

Competitive Energy but partly developed.

It may be assumed that, whatever the symptoms of a falling off in our sales abroad, the causes are not to be found in any decline of our industrial efficiency or in a more strenuous competition on the part of Europe. It is evident, however, that, if we would again attain the rate of progress of a year ago and keep it against all comers, we must avail ourselves of something more than the indigenous resources that have been described. As yet, we can not be said to have made full use of our powers. It must not be forgotten that, as has frequently been pointed out, our sudden and surprising success in invading Europe with manufactured goods was due, not to concerted and systematic effort on our part, but to the need of finding outlets for surplus product and the unlooked for recognition by European purchasers of the superiority of many articles of American manufacture. To a very great extent, our goods have sold themselves in the European markets, and that, too, in the face of high tariffs, of the hostility of industrial interests, and of a very general indisposition on the part of our manufacturers to adapt their styles, patterns, etc., to the tastes or prejudices of foreign consumers.

Necessary Aids to Future Growth.

It may be said, indeed, that we have hardly more than entered upon a novitiate in fitting ourselves for international competition. The establishment of sample warehouses and agencies at important trade centers, the employment of commercial travelers conversant with the language, customs, trade usages of particular countries; the development of adequate banking and transportation facilities; the adoption of proper methods of packing; the offering of more liberal credits —these are some of the conditions of the full utilization of our opportunities in foreign markets. If to these is added provision for a larger volume of exchange with countries which, to a greater or less extent, are now excluded from our markets, the real strength of our competitive powers will be developed.

Increasing Popular Interest in Foreign Trade.

It is encouraging to note that the people of the United States are becoming more and more sensible of the value of foreign trade and the importance of intelligent and well-directed efforts for its expansion. The growth of popular comprehension and approval is illustrated not only by the establishment of commercial museums, the organization of export associations, the demand for the creation of a separate department of the Federal Government having special charge of industry and commerce, and for the improvement of the consular service as an agency of commercial expansion, but also by the fact that our educational institutions, one after another, are rapidly adopting commercial instruction as an important feature of their work. Even the ordinary high schools are engrafting commercial geography upon their courses, and during the past year, the Bureau of Foreign Commerce has received applications from teachers and scholars in many parts of the country for copies of monthly and other consular reports as aids in this branch of study. The requests for information as to trade conditions in foreign countries from manufacturers and exporters have multiplied rapidly, and it may now be said that there is hardly an important business concern in the United States having a present or prospective interest in foreign trade which does not avail itself of the data furnished by the consular service.

Conditions in Undeveloped Markets.

The relation of the economic forces of the United States to those of Europe may be taken as the surest index to the probable future of our trade with the rest of the world; for it must be evident that, if we can continue to compete with European industries in their home markets, we shall have but little to fear from their rivalry in the neutral or undeveloped markets, where we would meet them on an equal footing.

Even in Canada, notwithstanding a preferential tariff of 33⅓ per cent. in favor of British imports, we continue, says Consul-General Bittinger, of Montreal, to enjoy 'more of Canadian customs than the rest of the world put together,' and many classes of goods which some years ago were bought in Great Britain are now more cheaply and more conveniently purchased in the United States. Last year, our sales to Canada amounted to more than $110,000,000, while those of Great Britain were only about $43,000,000. In Mexico, Consul General Barlow reports, the purchases from the United States show a large increase—over $4,000,000, or 11.8 per cent—while those from every other country exporting largely to Mexico, except Germany, show a large decrease. The German gain was only about $411,000, or 5.8 per cent. In the reports from Central America and South America, there are gratifying indications of substantial growth in the sales of our goods, and we are steadily widening the variety of our exports to Africa, Asia, Australasia—in other words, to every part of the world.

Commercial Work of Consular Officers.

In the 'Review of the World's Commerce' introductory to the annual reports for 1901* the effort has been made to summarize the detailed reports of the consular officers in such a way as to bring out the points of chief interest as to the trade and industries of the various countries and the obstacles to, as well as the opportunities for, the sale of American goods. It is but due to the consular officers to add that the quality of their work shows continued improvement, and that, thanks to their industry and promptitude, the Department is again enabled to transmit the annual reports to Congress within a month after the close of the calendar year.

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*'Commercial Relations of the United States' (in press).

THE SOIL AS AN ECONOMIC AND SOCIAL FACTOR.

By FRANK K. CAMERON,
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THERE is no part of the material world about us that is more intimately connected with the general welfare of the people than the soil. It has often been said, and well said, that it is the foundation of agriculture, in more senses than one. And the importance of agriculture in our present social systems is too well understood to justify any further comment here.

For practically a century the study of soils, and the phenomena they present, has received the attention of some of the ablest and most distinguished savants the ranks of science have held. Much is now known about soils from the point of view of the geologist, the physicist, the chemist and the bacteriologist. Much more is yet to be learned, and this perhaps is not the least interesting feature of the subject to one of a philosophic or scientific turn of mind. But when the geologist, the physicist, the chemist and the bacteriologist have brought together all the data and material of which they are capable, and have presented it to the world in accessible form, it is evident that but a very small part of the study of soils has been accomplished, or can be accomplished, by them.

It is necessary, as this paper will endeavor to show, that upon the labors of those investigators who have worked from the point of view of the natural sciences, the economist and the sociologist must build for the best development and use of the soil. They seem, up to the present, to have given very little attention to the subject, and the general knowledge of it seems to be summed up in the saying—'A poor soil, a poor people; a rich soil, a rich people.' This aphorism is in fact the immediate text of this paper. It implies what is apparently self-evident—that the soil is an economic factor because upon its character and the treatment of it depends the success of agricultural operations; and it is a social factor because the character of the soil in a very large measure determines the character of the people living upon it. The causal connection between the typical Yankee's well-known characteristics and his peculiar soils and environments has become almost classical in our literature. That which exists between some of the poor white communities in our Southern States and their soils is even more obvious. And just as striking are the opposite conditions on some of the rich limestone soils of our eastern states, or some of the intensely cultivated, rich, irrigated districts of the west.

Like all popular sayings, this one contains much truth. But it is sometimes untrue or at least misleading. For whether or not the soil be poor will depend entirely upon the point of view, and that there may be at least more than one point of view for any given soil will, it is believed, become evident from the following pages. Soils which are seemingly poor, and supporting but a poor population, may be in fact, or at least potentially, quite rich. But in order to make plain what is meant, it will be well to point out briefly some of the facts that are now known, and some of the views that are held by those who are making an especial study of soils. It will not be necessary to go into very much detail, for it will be sufficient to present the leading ideas in a general way in order to show that the work of the physical scientist touches, as a necessary consequence, both the field of economics and sociology. From these points of contact the effort will be made to indicate a few at least of the social and economic possibilities which a study of the soil presents, and to submit a plea that those to whom we look as leaders in these latter directions will find this subject of such importance and of so much interest that they will be impelled to do something towards the development of this side of it for the benefit of our country and possibly mankind at large. It would seem, as indicated above, that an almost virgin field for investigation is offered here, which can hardly fail to yield rich rewards to the student.

The soil is a very complex, heterogeneous mixture, or as one may say technically, material system. It is composed of three distinct parts or phases: First, the mineral and organic matters in a solid condition; second, the water, or water solution, which all soils contain; and third, the gaseous part, which fills the interstitial spaces between the solid components of the soil not occupied by the ground solutions. Furthermore, the soil is in contact with the atmosphere above it. It is probably from the ground solutions alone, or almost entirely alone, that the plants take their nutriment as far as the soil itself is concerned. Of course it is perfectly well known that the carbon and oxygen, which form so large a part of the plant tissues, are obtained mainly from the atmosphere above the soil and in contact with it. But the plant can derive its mineral foods from the soil solution only, and it is upon the concentration and composition of the solution that the well-being of the plant is primarily dependent. The nature of this soil solution is in turn dependent both upon the nature of the solid and of the gaseous components of the soil. Furthermore, it is intimately connected with the physical conditions of the soil—that is to say, with its texture, or the size of the solid particles, and the structure, or the arrangement of the particles, mainly because upon these factors depends the amount of water which the soil will hold under any given conditions of temperature, climate, etc. And upon the amount of water which it will hold

will depend in turn the composition and nature of the soil solution. The soil, then, is composed of something more than the solid components alone, and this point of view is well worth accentuating, because it is not always recognized, and because upon it is dependent much of the modern development in soil studies.

The solid components of the soil are derived from two general sources. The mineral components are derived from the decomposition of the subsoil, or the underlying rocks. Or at least from rocks, although perhaps at some distance, when the soil has been carried to its present position by water, wind or other like agencies. Besides these mineral components of the soil, there are always more or less detritus and organic remains from the decomposition and breaking down of organic tissues from the present and former vegetation.

It is true that some of the components of the soil are so very little soluble as to be called in popular language insoluble. But there is, in reality, no such thing as an insoluble substance, and even those components of the soil which most nearly approach this condition are, to some extent at least, soluble in the ground water. And it is from these slightly soluble minerals and organic substances that the ground solution obtains its dissolved material, which serves in turn as food for the plant when presented in this available form. By the action of atmospheric agencies, oxidation, etc., by the solvent action of the water, by the action of dissolved gases, such as carbon dioxide for instance, and by the action of numerous microorganisms which exist in practically all soils, both the mineral and organic matters are broken down, decomposed, and part of them made more soluble. This is essentially the process known as weathering, and it is going on all the time. It may be checked, or it may be augmented, but it cannot be stopped entirely. It is nature's method for bringing the mineral nutriments in the soil into such forms as to be 'available' for plant nourishment, in contradistinction to that potential plant food which is present, but in such forms as to be unavailable. The distinction between available and non-available plant food, while now sufficiently obvious, was not recognized in the earlier studies, and marks in fact one of the first great steps forward in soil investigations.

Plants do not take from the soil solution the various dissolved substances which it contains in the same relative proportions in which they are present. Therefore by the continued growth of a particular kind of crop, and its periodic removal by cropping, it may happen that some one or more of the necessary plant nutrients in the soil may be removed more rapidly than others or than the normal weathering of the soil can furnish it to the soil solution. If this process is continued far enough, the plants fail to thrive and the soil becomes barren, or, as it is popularly phrased, exhausted. Much that is incorrect is

popularly believed on this subject of exhaustion. There is probably no such thing, in a strict interpretation of the term, as an exhausted soil, for it is pretty thoroughly established that although a condition of the soil may have been brought about, as just described, in which it is not suited to the growth of a particular crop, it may be very well suited indeed to some other crop, and generally is suited to some other crop, and so the term 'exhaustion' in this sense is really a relative one only. It has likewise been pretty thoroughly established now that plants, like animals, need a varied, and, as it is sometimes called, 'balanced' ration; that there is a particular combination or proportion of various constituents in the nutrients which is best adapted to a plant at any particular stage of its growth. For example, it is well understood that for the development of a grain crop, especially at the time when the grain is forming, a certain amount of magnesia is necessary. But if the ratio of the magnesia to the other necessary mineral elements is above a certain figure, the soil solutions become extremely toxic, with the results that the crops fail and the soil is barren. It has been found that the absolute amount of the magnesia which may be present and probably causing the barrenness of a given area is extremely small—so small, indeed, as to be difficult of accurate estimation. But if the ratio of other elements to the magnesia, for instance lime, be raised sufficiently high, the plants will do remarkably well, and, up to a certain limit, the more magnesia, the better they will do, so long as the ratio of the magnesia to the lime does not become too high. These views will explain what was meant when it was said above that the fertility or nonfertility of the soil is relative, and it is as a matter of fact, the explanation of the earlier remark that the expression 'a poor soil, a poor people, etc.,' may be misleading, if not positively untrue. For it is very probable that there is no soil which is cultivatable at all which could not be regarded as a fertile soil for some crop.

It is possible to modify the conditions as to the fertility in any given soil by *tillage,* which changes the physical condition of the soil and removes interfering growth from the crop we wish to cultivate; which, on the one hand, promotes capillary rise of water from the lower depths of the soil, or, on the other hand, cuts it off from the surface to prevent its too rapid escape; and which may improve the physical condition of the soil and further promote the natural rate of decomposition or weathering. Again it has been found in modern times that the *rotation of crops,* or change of crops, will aid the soil. And the reason for this probably lies in large part in the fact, as noted before, that one crop requires a different proportion of constituents in the soil from another, and if it is changed in the proportions of the constituents present, it is still adapted to the succeeding crop, giving time for those which became deficient through the growth of the first crop, to be again

accumulated in sufficient quantity and relative proportion. Other factors enter of course into rotation, such as change of the texture of the soil produced by one crop making it better for another, the elimination of parasites, etc.

A third method is that of *fertilizing,* and a most complex group of phenomena is involved in this practice. The function of fertilizing is probably three-fold at least. The added material may change the texture, structure or other physical conditions of the soil, whether it be by mechanical mixture or by some other physical or physico-chemical process, such as is probably involved in the flocculation of clays by certain solutions. Its most obvious purpose, and the one which is the controlling idea among agriculturists at large, and perhaps to entirely too great an extent among the supposed scientific workers in this field, is the direct addition of plant food to the soil. It is not intended by this latter statement to minimize the importance of this function of fertilizers, but to insist in the most emphatic way that more attention should be given to the third function, that is—the changes in the solubility of the soil components already present induced by the addition of fertilizing materials, especially the so-called mineral fertilizers or salts. This is not the place for, nor would the space allotted to this paper permit of, a satisfactory discussion of the subject. Suffice it to say, for the present, that it is thoroughly well known, though not always generally recognized, that great changes in the solubility of the soil components already present may be brought about by the addition of foreign material, and in this sense the process of fertilizing is one of retarding or expediting the natural weathering of the soil components originally present.

Within the last few years, it has come to be recognized that bacteria or other microorganisms play a large part in the fertility of arable soils; that the development of some of these is desirable, that of others, not. And while this side of the subject is in hardly more than the preliminary stages of its development, yet a good deal is known as to the several conditions which make for the presence of the desirable organisms or *vice versa,* and these conditions are for the most part readily controlled. Furthermore, the point has been reached when we can actually inoculate the soil with desirable substances of this nature. There is no branch of soil study which is offering greater promise of advancement at the present time than this. And the opportunities it offers for increasing our control over soil conditions augurs much for improved agricultural practices. Here again it seems worth while to call attention to the fact that these organisms are valuable not only for themselves, or rather the immediate products of their activities, but also quite as much probably for their influence upon the soil components already present, either in breaking them down into simpler forms or in

general in making them more soluble in the ground waters, and thus more available to plant nutrition.

It will thus be seen that it is possible to control, in a measure, the soil. In another way much has been done in controlling soil and soil conditions, and that is in controlling the climate above the soil. This climate, or condition of the atmosphere above the soil and in contact with it, is also a most important factor in the growth and development of plants, and any way in which this can be controlled, correspondingly can the development of the plants be controlled. This is familiar to every one in the use of frames, hot-houses and conservatories, and, in some of the modern structures of this kind, it can hardly be said that the method is one adapted to a small scale only. In illustration, attention might be called to an establishment in Rhode Island which has upwards of fourteen acres under glass for the cultivation of one crop alone. And this can hardly be regarded as an isolated instance. Many others as extensive, or perhaps even more extensive, might be cited. In the last few years an even more striking illustration, because much greater in extent, of this control of climate has been developed in this country. For this purpose as well as for some other reasons, enormous areas in Florida are covered with either slats or cloth tent-like arrangements. These are erected for the purpose of protecting the plants and developing abnormal or unusual growth in certain varieties of tobacco, and have proved immensely successful in prolonging the growing season, through a modification of the climate about the plant, keeping it moist and warm, not cutting off the light entirely, but partially, and preventing the great evaporation from the surface which would dry the soil, and hasten the ripening of the plant. The experiment has been repeated in Connecticut under the auspices of the Bureau of Soils, U. S. Department of Agriculture, in cooperation with the Connecticut Experiment Station, over a very considerable area, sometimes single fields of as much as eight acres in extent being now protected by these cloth coverings for the production of a high-grade wrapper leaf tobacco. The shading of one crop by another with a taller, umbrageous growth, is a similar procedure. And this is practiced quite extensively in some places, as in the shading of coffee trees by larger tree growths, or the more familiar nurse crops, common in some parts of the United States. Modifications of the climate in other ways, by planting of trees, erection of wind brakes, and devices of a similar nature, have been used with greater or less success in certain regions, and are all more or less well known.

It is thus possible to greatly modify the soil and the soil conditions. Nevertheless the fact remains that it is impossible to make one soil just like any other soil. Consequently characteristic differences do exist in them, and it follows that some soils are adapted to some purposes for

which other soils, which are in themselves very good, are totally unsuitable. And this leads at once to the idea of the adaptation of special crops to special soils.

In a general way it has long been recognized that certain soils are unusually well adapted to the production of particular crops, as the celery soils of Kalamazoo, the wheat soils of the Red River valley, etc. But it is not generally recognized that each particular individual soil is best adapted to some particular crop or rotation of crops, and perhaps the greatest economic sin of the farmers of this country has been the almost general refusal to appreciate this cardinal, fundamental truth. Much improvement in this direction is to be noted within the last few years. It has come to be more and more recognized that at least some soils are more profitable when confined to the production of particular crops, as with the lettuce soils about Boston, the soils of the apple belt through the middle Western States, the soils of the sugar-beet areas, the sandy truck soils of the Atlantic seaboard, all coming into prominence for the particular crops cited.

Something more than merely empirical determinations on this subject can now be recorded; and perhaps the most striking illustration is a development of certain soils in the Connecticut Valley, which soils were generally regarded as very poor and practically valueless, until it was pointed out as the result of the soil survey of the Connecticut Valley by the Bureau of Soils, U. S. Department of Agriculture, that these very soils were markedly similar to those of Florida, on which the best Sumatra seed tobaccos were grown. The climate of the Connecticut Valley during the growing season is not very different from that of Florida, and by the use of the tent-like arrangements for shading, to which reference was made above, climatic conditions over the soils in both Connecticut and Florida can be made very similar indeed. This has actually been done, and there is now being grown in the Connecticut Valley a fine grade of cigar wrapper, which apparently equals in every respect the best product of Florida or of the Island of Sumatra itself. This is but one of the most striking of several similar developments for particular types of soil to which attention might be directed, where the possibilities have clearly been seen, before the introduction of a crop or dependent industry. Many thousands of dollars have thus been brought to the producers, and this, than which there could be no greater, is a powerful economic argument for the liberal support of soil studies on a broad, but systematic, basis.

With this idea of the adaptation of particular soils to particular crops, it becomes evident at once that the classification of the agricultural soils is not only desirable, but a fundamental necessity for the thorough scientific study of the soils of the country. This necessity is now so well recognized that the national government

is supporting a large and growing bureau in the Department of Agriculture for the classifying and mapping of the soils in the principal agricultural areas, supporting these surveys with strong laboratories for the investigation of soil phenomena, its management and economic control. More interesting to note, is the growth of this work with some of the individual states which, either in cooperation with the surveys of the national government or individually, are now annually expending many thousands of dollars in this direction, with the firm conviction that in no other way could a surer investment be secured for ultimate large returns. But the work upon soils, thus hastily sketched, has been and is being done almost entirely upon the physical side. This has been, in the past, in accordance with the peculiar nature of the case. But there is another side, no less important, as difficult, possibly more difficult, to handle, giving justification for the title to this paper.

The results which are being obtained both by the national Department of Agriculture, by the many experiment stations, and other agricultural institutions connected with the American universities, are being freely disseminated among the people, and the major part of the results obtained abroad, not only in England, Germany and France, but in Russia, Sweden, Norway, Holland, Japan and elsewhere, are available to any intelligent farmer in this country who cares to take a little trouble and pains to obtain them. This being the case, the question naturally arises as to the reason why the practical agriculturists of this country make so little use of these results. For it is not to be doubted that the agricultural possibilities of the soils of the United States are very great—certainly much greater than has been realized thus far. The answer to this question is partly a psychological and wholly a sociological one. With some few exceptions, the farmers at large do not approach their occupation with the point of view connoted by the term 'business principles.' Perhaps this idea is best brought out in the yet current classification of man's occupations into the learned professions, farming and business. It is generally recognized by all professional men that their best success is obtained when the principles of business men are applied to their own affairs. As a matter of fact, what are usually called business principles are sound scientific methods. But this has not been recognized as yet by the main body of farmers in this country, and they seem to be actuated in the management of their farms largely by sentiment, much as some men take their religion or their politics, because their fathers managed in this way, therefore that is the way in which they should manage. Their forebears did well, under vastly different conditions and standards than those which obtain to-day, and the obvious fact that the descendants are not doing so well is met with all manner of explanations and excuses, which, just as obviously, have little or nothing to do with

the case. Instead of studying a soil and its situation, and determining to what crop, or rotation of crops, it may be best adapted, the farmer continues to cultivate the same crops his predecessors grew, or he puts in one he may happen to wish for some fancied reason, possibly in some cases caprice. For example, a man may wish a grass farm, and instead of studying his soils to determine if they be adapted to this purpose, he may sink hundreds of dollars in a vain attempt, foreordained necessarily to failure, which might have been as surely foreseen. A good illustration is the tobacco crop in southern Maryland. In many ways, it is a fine crop to grow, making an attractive, handsome appearance in the field, pleasing to one's esthetic sense. Moreover, it has been grown in this region from time immemorial. But for various reasons, it can no longer compete successfully with tobaccos from some other regions, and now brings but very little money. Nevertheless, the people are accustomed to this crop, they like its cultivation, and consequently it remains a staple, although it is very well known that the soils devoted to it are much better adapted to certain other crops which would indubitably yield a vastly greater money return.

Over the wider areas of our country this seems to be about the spirit in which agricultural conditions are still viewed and met. Where intensive agriculture is practised, as in the truck soils, or in the irrigated soils of the West, this is not the case, or not so frequently the case, and can never be where intensive methods are practised, for it is a necessary corollary of the high prices which lands under the intensive system of cultivation command, that the crops for which they are best adapted must be raised, or absolute failure inevitably follows. But where the extensive methods of cultivation are practised, it is usually possible to drift along on half crops or third crops, and still keep matters going on a gradual decline until conditions are so bad that the land is abandoned as barren, and pastures new are sought elsewhere.

While the soil may be best adapted to some particular crop or rotation, other conditions enter, or may make it more desirable to substitute a different crop or rotation not so well suited. For questions of transportation, or supply and demand, and of available labor, inevitably enter into the business management of every farmer, and thus the soil is an economic factor in every community. In certain areas of Arizona, for instance, the soils, climatic conditions and general features indicate most strongly the advisability of raising fruits. But the transportation facilities up to the present have been so unsatisfactory that it has been impossible for the Arizona horticulturists, even with earlier crops than California, to put their products on the Eastern markets at such figures as to compete satisfactorily with those from the latter state. Again a case comes to mind of a plantation in eastern North Carolina, with an unusually fine crop of peanuts, covering about 400

acres, at a time when the market was in a remarkably satisfactory condition. Yet this crop was a complete and disastrous failure because the unreliable labor conditions existing in that locality prevented the proprietor from securing more than a quarter of his crop, the greater part of it remaining on the ground to rot or to be devoured by birds, etc. Thus it is that the management of the soil, as in every other practical policy in this world, must be largely a give-and-take matter, or a question of double-entry bookkeeping, so to speak, and manifold considerations are involved. Where one gains in one way, he loses in another, and it is sound judgment or business sense which will determine what is the best thing to be done in any given case to get the most out of the soil under the conditions surrounding it.

Opportunities to get just such training as is necessary for the intelligent management of the soil are readily accessible in this country. Agricultural colleges and other colleges not professedly so, but giving courses in agriculture, both on the theoretical and on the practical side, are numerous. The necessary expense of attending them is certainly not great, and well within the means of a very large number of the youth in the rural districts. But it is an astonishing fact that they are not availed of, astonishing because to one of a philosophical or scientific cast of mind, there are few, if any, fields more interesting, or better adapted to the practical application of scientific methods than those of agriculture, and especially of soil management. Yet in our so-called schools of agriculture and mechanic arts it is indeed unusual when the number of students, presumably farmers' sons, who graduate in the mechanical arts as engineers, surveyors, etc., do not largely outnumber the students taking their degree in the strictly agricultural courses. This is even more astonishing when we reflect that there is a demand, and a growing demand, in this country for skilled agriculturists to manage the estates either of rich individuals or of corporations, and the development of special crops for special industries. The demand for men of this description is at the present time greater than the supply, and such as have the proper training and qualifications can command salaries from $1,500 to $4,000 or $5,000 per year, possibly, in exceptional cases, much more. A case could be cited, where a fine house and grounds and $10,000 per year were offered to a certain expert to take charge of a large plantation devoted mainly to the production of a particular crop. These salaries are far above the average incomes of young men in other branches of professional life. The life is in other ways an attractive one; it requires more or less aptitude in the qualifications of the student, for, as in every other branch of professional life, the successful man is one that necessarily keeps up with modern developments along his line; but it must from the nature of the

case be largely an out-of-door life, and attractive to any one who has the least spark of the love of nature in his soul.

It would unquestionably be a most interesting and fruitful line of investigation for the sociologist to study the causes which are apparently diverting men from this most attractive field of labor. There are some popular conceptions upon this subject, we know. It is generally admitted that there is a tendency for men to congregate in the cities or the towns in preference to remaining in the country, and various reasons are assigned for it. We hear much in this connection of the gregarious instinct of man, but this is hardly a sufficient reason. For the entire trend of modern scientific agriculture is towards intensive cultivation, and the gregarious instinct should be sufficiently gratified in populations where this method prevails. On the other hand, it is sometimes held that the chances for development in a social sense are greater in other professions or occupations, such as business life, and these are having their effect upon the youth of the country. This may be true to some extent, for it is as natural for man to prefer fine clothes as it is for birds to prefer fine feathers, and the accepted garb of the farmer is certainly not as attractive to mankind at large as the every-day costume of the physician, clergyman or clerk. But that it can be as potent as it is generally believed scarcely seems probable, unless one is to accept the notion that the farming class, speaking in a broad way, is no more intelligent than the class from which the average servant girl of the city comes.

The opportunities for the development of special lines in agriculture and soil management are certainly as great and should be as attractive as in other professions. There is as great an opportunity for the development of experts in sugar-beet-raising, apple-raising, rose-raising, as for the development of specialists in eye, ear and throat treatment, corporation law or criminal procedure, mechanical engineering or electrical engineering, etc., and with this unusual knowledge and unusual ability along specialized lines will come also the unusual pecuniary emoluments that are found in other professions.

Many problems of a sociological or economic nature suggest themselves in this connection, and it is certainly not from lack of subjects or material that the literature is nearly barren. But the object of this paper is to call attention to this subject, rather than to discuss it, which must be left for abler and better fitted pens. The development of new countries, as influenced by the soils, such as in the case of the westward movement from the tide-water regions of the Atlantic slope, along the limestone belt of Pennsylvania, Maryland, Virginia, Kentucky, Tennessee and Ohio; the differences which do, and must of necessity, exist between communities practising intensive or extensive methods of cultivation; the land-rich and money-poor man,

and his status in the community; whether it is advisable in the general interest of the state, to encourage the development of large or small farms; whether the methods in vogue in some other industries, the combinations of resources and capital sometimes developing into 'trusts' can be successfully adapted and applied to agricultural pursuits; the building up of infant agricultural industries, by government aid, or the extension of the principle of protection to agricultural productions, and dependent industries; whether, on the whole, it would be better to make for a complete specialization, or whether it would be more advisable for each farming community to raise its own necessities —these are but some of the problems which are directly connected with the soil and the soil management, and are also social and economic questions. It therefore seems appropriate to those of us who are interested in this study from the point of view of the natural sciences, or applied science, as it is the fashion to call it now-a-days, to enter a strong plea that our efforts should be seconded by a more serious attention to this same subject from the professional economist and sociologist.

THE DRAINING OF THE ZUIDER SEA.

By Professor J. H. GORE,
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'GOD made the world, but the Dutch made Holland' is a saying quite common with people who visit the Netherlands; and as one looks upon the great sea dykes that keep the North Sea from sweeping over North Holland or the smaller dykes that hold the rivers within their channels, it is easy to see that the retention of the land created is possible only with great vigilance and care. Lakes have been drained and their beds converted into arable land, useless bends have been taken from the rivers and the ground, once covered by marshes, has become fertile gardens. The map of Holland shows many changes, not only in the coast line, but in the water covered areas within.

The draining of the Haarlem Lake was looked upon as a marvel of engineering skill and patient industry, but the work here discussed is far greater in magnitude and presents technical and economic difficulties never before encountered.

A clause in the constitution of the United Netherlands permits the organization of new provinces. However, when it was written, there was in mind the possibility of rearranging the eleven provinces in such a way as to enlarge the number. The acquisition of territory of any considerable area was not thought of until 1848, when it was proposed to drain the Zuider Sea, which, if accomplished, would add a province somewhat larger than Zeeland.

In 1892, Queen Emma appointed a commission, consisting of the Minister of Water Affairs and twenty-nine members to consider the general question of converting this shallow inland sea into agricultural lands. Two years later, a very elaborate report was submitted, in which the problem was discussed from every conceivable standpoint. So many questions were raised in this report and so much discussion was provoked that it was not until last summer that the people generally realized what the Commission actually proposed and how the work was to be done. The air has been sufficiently cleared to enable one to assert that while it is universally conceded to be possible to drain as much of this sea as may be desired, there remains the feeling that while the cost of this undertaking is certain, the benefits are by no means sure.

It is proposed to build a sea dyke from Ewijksluis in North Holland over the island of Wieringen to the Frisian Coast near Piaam, a dis-

tance of 24.8 miles, the cost $16,000,000 and to require nine years to build.

This route was selected because it would be possible to construct the locks in the solid ground of the island and, though not the shortest line that could be selected, it would be in the shallowest water and so far south that some of the streams flowing into the sea would have their outlets outside of the district to be drained. Along the top of this dyke it is intended to have a railroad, thereby shortening the distance by rail from North Holland to Groningen by 35 miles—a matter of considerable importance in a country where no distances are great.

By shutting out the North Sea, the water left in the Zuider Sea would be fresh, and it was feared that this change would cause the death of the vegetation along the shores and that sickness would result from its decay. But the freshening process would be so gradual that there would be abundant opportunity for an adaptation of vegetation to the changing conditions. The entire scheme contemplates a step-by-step process. That is, after completing the sea dyke, so that the inflow of water can be stopped and the outflow regulated by the use of the sluice gates, it is proposed to surround in the northwest corner of the imprisoned sea about 52,620 acres and from this pump out the water. As fast as the land within this dyke should become free from water it would be subdivided by ditches like the rest of Holland and placed under cultivation at the earliest possible moment. It is believed that this can be done in five years and that the cost would be about $5,000,000.

The portion of the sea to be included in this, as well as in other polders, the name given to drained areas, has been determined from many thousand borings, and also from the desire to avoid stopping up or diverting any of the larger streams that now empty into the sea.

After putting this polder in good shape, the southeast corner will be dyked in and the water pumped out, yielding ultimately 249,000 acres. This will require ten years and the cost is estimated at $24,740,000. After this shall have been completed 77,800 acres will be enclosed in the southwestern section of the sea. The work of converting this into arable land will require four years, and cost $9,140,000. The last section to be drained will be in the northeast, where $125,649 acres will be added to the domain after five years' work at an estimated cost of $14,000,000.

The polders have been selected so as to leave undisturbed every important city now on the sea, and also to allow all the rivers to empty into the part of the sea not included. The plan also contemplates the deepening of the mouth of the Ysel, the broadening of the entrance to Amsterdam, and the improving of the outlets of all the rivers now emptying into the Zuider Sea, in this way bettering the condition of

all the harbors, placing the canals under better control and converting the remnants of the sea into a body of fresh water, so that in case of overflows the land will not be damaged as it is now.

By doing the work in this piecemeal fashion, covering thirty-three years, only 24,000 acres will be added annually. This can be brought under cultivation without causing any disturbance to agricultural conditions in the country or affecting the markets of foodstuffs. Then too, by the gradual draining of the sea the fishery interests will not be suddenly imperilled, and persons now engaged in fishing will have time to adjust themselves to the new conditions.

Heretofore the littoral rights have been the most difficult to adjust. The people realized that many of the cities of Holland have been 'built on herring bones,' that the fishing fleets were the schools in which so many Dutchmen had learned the sailors' trade, and that it was on the sea that Holland won her greatest victories of peace as well as of war. The Commission, therefore, made a close study of this question. They ascertained how much money is invested in the Zuider Sea fisheries, how many men are employed, and what the annual catch amounts to. They learned that the investment was less than had been surmised, that many of the fishermen spent only a small part of the time fishing and that acre for acre the egg sales in the Haarlem polder exceeded the fish caught from the Zuider Sea. However, it is understood that some must suffer in being obliged to change their mode of earning a livelihood, and provision is made for lending assistance. All persons having vessels large enough to engage in the North Sea fisheries are to be exempt from harbor dues when returning with a catch; all men over fifty-five years of age who are now devoting the greater part of their time to fishing will receive a pension, and the smaller craft will be purchased by the State.

When this new province becomes a part of the Union, it will be divided into districts of the most approved size, with ground reserved for schools, churches, cemeteries and town halls.

But it is not intended to sell the land thus acquired. The interest on first cost and the maintenance is all that is asked of the occupants who become perpetual lessees of the ground. This amounts to an annual tax of about $7 per acre. The rentors are to erect their own buildings and be subject to the usual rate of asssessment on all personal property. Inasmuch as land in the Y polder rents for twenty dollars per acre and some for even more, it is thought that the price here expected can be easily obtained.

Dividing up the sea by polders and building a sea dyke across its mouth will lessen the dangers from storms and overflows and diminish the cost of maintenance of the long dyke that now fringes the entire sea. By leaving open water between the polders where the deepest

water is now found, there will be no impeding of intercourse between the larger cities that now enjoy boat communication.

One would expect to see the financial features well considered. The Commission asks the State to pay annually $758,000 for 33 years, and to raise this amount by the issue of Zuider Sea bonds of 100 florins (about $40) each. These bonds to be sold in the open market or given in exchange for deposits in the Postal Savings Bank. The bonds are to yield 2.6 per cent. and be legal tender in payment for ground rent. No one sees any difficulty in this plan of procuring the means. Dutch credit is good and the State finances have been so well managed that since 1850 the public debt has decreased by an amount in excess of what is deemed necessary to carry out this great plan.

The plan is not only feasible from a financial as well as from a technical standpoint—it is almost a necessity to the State. At the present time only 56 per cent. of the land is cultivated by the owners, and the number of small farms—less than two acres, has increased at the rate of 2,072 per year during the past ten years. The demand for land is so great that rents are growing larger with the result that less surplus food stuff is available, and the people are therefore affected by the fluctuation in foreign markets. Then too the country is annually losing 5,000 of the strongest inhabitants who are forced from home in search of work.

In the immediate future a large proportion of these people could find work in the draining operations and, as the lands become available, the surplus population that must now seek homes in foreign lands, could find land in their own country and that, too, close to Amsterdam, its best market.

Holland has suffered more from storms on the inland waters and inundations therefrom than from the seas that skirt her coasts. The drying up of the Haarlem Lake removed one great source of danger and loss, but immunity will not come until the Zuider Sea, which has been a constant menace since 1440, yields her 787 square miles to the tillers of the soil.

The Dutchman is especially fitted for work of this sort. He calmly sits down, reckons up the cost of the undertaking, devises means and appliances and then proceeds with the work without troubling himself whether it will require one year or twenty. He does not expect to play the part of Canute and command the waters to recede, but ever conscious of the inroads that the sea has made upon his country, his work is sweetened perhaps by a feeling of revenge that he will reconquer all that has been lost and levy tribute for the 371 lives that were lost in 1885 by the breaking of some of the dykes.

The Government is willing to appropriate the requisite money just

as soon as the finances will permit and entrust the work to a contractor, knowing that every one of the 1,250,000 piles needed for the sea dyke alone will be put in place and that not a hundredweight of the 70,000 tons of basalt blocks will be missing. The Dutchman is so loyal and feels so much national pride that no imperfect work is ever found in Government contracts.

An idea of the magnitude of the work can be formed by glancing at a few figures.

The sea dyke will be 24.8 miles long, 114.5 feet across the top and 21.6 feet above high water; the river Ysel is to be carried out into the sea a distance of 10.5 miles with a width of 948 feet; the entrance to Amsterdam must be widened by two miles; dykes around the polders will be necessary having an aggregate length of 198 miles with an average height of 11.4 feet; in the Island of Wieringen, 30 locks will be required, 33 feet wide and 16 feet deep; an encircling canal must be constructed from Enkhuyzen to Uitdam, a distance of eight miles; the sea dykes on the Frisian coast must be heightened at a cost of $240,000 and four pumping stations with an aggregate of 16,930 horse power must be installed.

Though the undertaking is great, the entire commission agreed that it should be done, and twenty-one out of the twenty-eight believed that the State should be in control rather than to grant the concession to a private party. When finished the State can issue another medal, like the one minted to celebrate the draining of the Haarlem Lake to bear the inscription:

"Zuider Zee, after having for centuries assailed the surrounding fields, to enlarge itself by their destruction, conquered at last by the force of machinery, has returned to Holland its invaded land." And the historian of the work will close his account of the material gain to the State by saying: "But this is not all; we have driven forever from the bosom of our country a most dangerous enemy; we have at the same time augmented the means for defending our capital in time of war. We have conquered a province in a combat without tears and without blood, where science and genius took the place of generals, and where polder workmen were the worthy soldiers. Persevering to surmount the obstacles of nature, and those created by man, the country has accomplished, to its great honor and glory, one of the grandest enterprises of the age."

THE EVOLUTION OF FISHES.

By President DAVID STARR JORDAN,
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WHEN a fish dies he leaves no friends. His body is at once attacked by hundreds of creatures ranging from the one-celled protozoa and bacteria to individuals of his own species. His flesh is devoured, his bones are scattered, the gelatinous substance in them decays, and the phosphate of lime is in time dissolved in the water. For this reason few fishes of the millions who die each year leave any trace for future preservation. At the most, a few teeth, a fin spine or a bone buried in the clay might remain intact or in such condition as to be recognized.

But now and then it happens that a dead fish may fall in more fortunate conditions. On a sea bottom of fine clay the bones, or even the whole body, might be buried in such a way as to be sealed up and protected from total decomposition. The flesh would in any case disappear and leave no mark or at the most a mere cast of its surface. But the hard parts might persist, and now and then they do persist, the lime unchanged or else silicified or subjected to some other form of chemical substitution. Only the scales, the teeth, the bones, the spines and the fin rays can be preserved in the rocks of sea or lake bottom. In a few localities, as Green River in Wyoming, Monte Bolca in Tuscany and Mount Lebanon in Syria, with certain quarries in Scotland and lithographic stones in Germany, many skeletons of fishes have been found, pressed flat in layers of very fine rock, their structures traced as delicately as if actually drawn on the smooth stone. Fragments preserved in ruder fashion abound in the clays and even the sandstones of the earliest geologic ages. In most cases, however, fossil fishes are known from detached and scattered fragments, many of them, especially of the sharks, by the teeth alone. Fishes have occurred in all ages from the Silurian to the present time and no doubt the very first lived long before the Silurian.

No one can say what the earliest fishes were like, nor do we know what was their real relation to the worm-like forms among which men have sought their presumable ancestors, nor to the Tunicates and other chordate forms, not fish-like, but still degenerate relatives of the primeval fish.

From analogy we may suppose that the first fishes which ever were bore some resemblance to the lancelet, for that is a fish-like creature with every structure reduced to the lowest terms. But as the lancelet

has no hard parts, no bones, nor teeth, nor scales, nor fins, no traces of its kind are found among the fossils. If the primitive fish was like it in important respects, all record of this has necessarily vanished from the earth.

The next group of living fishes, the Cyclostomes, including the hag-fishes and lampreys,—fishes with small skull and brain but without limbs or jaws,—stands at a great distance above the lancelet in complexity of structure, and equally far from the true fishes in its primitive simplicity. In fact the lamprey is farther from the true fish in structure than a perch is from an eagle. Yet for all that it may be an offshoot from the primitive line of fish-descent. There is not much in the structure of the lamprey which may be preserved in the rocks. But the cartilaginous skull, the backbone, fins and teeth may sometimes leave their traces in soft clay or lithographic stone. These parts are actually represented in a fossil form bearing some likeness to a lamprey found in the Devonian of Scotland known as *Palæospondylus*. This early form was a highly specialized one with well-defined vertebræ, a fact which shows that the group had reached a relatively high development even in these early times. The few existing Cyclostomes may even be looked upon as degraded types as compared with their Devonian ancestors.

Besides the lampreys the Devonian seas swarmed with mysterious creatures covered with a coat of mail, fish-like in some regards, but limbless, without true jaws and having next to nothing in common with the fishes of to-day. These are called Ostracophori, and most recent authorities, as Woodward and Dean, are inclined to regard them as highly modified or specialized lampreys, a side offshoot which has left no descendants among recent forms. Cope has compared these Ostracoderms to the larva of Tunicates, and Patten has suggested their affinity to spiders, or rather to the horseshoe crab (*Limulus*), which is at least as much spider as crab. The weight of evidence would rather place them nearest the lampreys, but certainly not in the same natural class.

Among these forms in coat of mail are some in which the jointed and movable angles of the head suggest the pectoral spines of some catfishes. But in spite of its resemblance to a fin, the spine of the pectoral fin in *Pterichthys* is an outgrowth of the ossified skin and has no more homology with the spines of fishes than the mailed plates have with the bones of a fish's cranium. In none of these fishes has any trace of an internal skeleton been found. It must have retained its primitive gelatinous character. There are, however, some traces of eyes, and the mucous channels of the lateral line indicate that these creatures possessed some other special senses.

Whatever the Ostracophores may be, they are not true fishes and they should not be included within the much-abused term *Ganoidei*,

a word once used in the widest fashion for all sorts of mailed fishes, but little by little restricted to the hard-scaled relatives and ancestors of the gar-pike of to-day.

Dimly seen in the vast darkness of Paleozoic time are the huge figures known as Arthrognaths. These are mailed and helmeted fishes, limbless so far as we know, but with sharp, notched, turtle-like jaws quite different from those of the fish or those of any animal alive to-day. These creatures appear in Silurian rocks and are especially abundant in the fossil beds of Ohio, where Newberry, Claypole, Eastman and Dean have patiently studied the broken fragments of their armor. Most of them have a great casque on the head with a shield at the neck and a movable joint connecting the two. Among them was almost every variation in size and form.

These creatures have been often called ganoids, but with the true ganoids like the gar-pike they have seemingly nothing in common. They are very different from the Ostracophores. To regard them as derived from ancestral Dipnoi is to give a possible guess as to their origin and a very unsatisfactory guess at that. But they have all passed away in competition with the scaly fishes and sharks of later evolution, and it seems certain that they, like the mailed Ostracophores, have left no descendants.

Next after the lampreys, but a long way after in structure as in time, come the sharks. With the sharks appear for the first time true limbs and the lower jaw. The upper jaw is still formed from the palate, and the shoulder girdle is attached behind the skull. "Little is known," says Professor Dean, "of the primitive stem of the sharks and even the lines of descent of the different members of the group can only be generally suggested. The development of recent forms has yielded few results of undoubted value to the phylogenist. It would appear is if paleontology alone could solve the puzzles of their descent."

Of the very earliest sharks in the Upper Silurian age the remains are too scanty to prove much save that there were sharks in abundance and variety. Spines, teeth, fragments of shagreen, show that in some regards these forms were highly specialized. In the Carboniferous age, according to Dean, 'there occurred the culminating point of their differentiation when specialized sharks existed, whose varied structures are paralleled only by those of the existing bony fishes,—sharks fitted to the most special environment, some minute and delicate, others enormous, heavy and sluggish, with stout head and fin spines and elaborate types of dentition.'

The sharks are, however, doubtless evolved from the still more primitive shark without limbs and with the teeth slowly formed from modification of the ordinary shagreen prickles. In determining the earliest among the several primitive types of shark we are stopped by

an undetermined question of theory. What is the origin of paired limbs? Are these formed, like the unpaired fins, from the breaking up of a continuous fold of skin, in accordance with the view of Balfour and others? Or is the primitive limb, as supposed by Gegenbaur, a modification of the bony gill-arch? Or again, as supposed by Kerr, is it a modification of the hard axis of an external gill?

If we adopt the views of Gegenbaur or Kerr, the earliest type of limb is the jointed *archipterygium,* a series of consecutive rounded cartilagenous elements with a fringe of rays along its length. Sharks possessing this form of limb (Ichthyotomi) appear in the earliest rocks, and from these the Dipnoi, on the one hand, may be descended and, on the other, the true sharks and the Chimæras.

On the other hand, if we regard the paired fins as parts of a lateral fold of skin, we find primitive sharks to bear out our conclusions. In *Cladoselache* of the Subcarboniferous, the pectoral and the ventral fins are long and low, and arranged just as they might be if Balfour's theory were true. *Acanthoëssus,* with a spine in each paired fin and no other rays, might be a specialization of this type or fin, and *Climatius* with rows of spines in place of pectorals and ventrals might be held to bear out the same idea. But in all these, the tail is less primitive than in the *Ichthyotomi.* On the whole, however, there is much to be said on the primitive nature of the Ichthyotomi, and *Pleuracanthus,* with the tapering tail and jointed pectoral fin of a dipnoan, with other traits of a shark, is as likely as *Cladoselache* to point directly to the origin of the shark-like forms.

Hasse finds this origin in a hypothetical group of Polyospondyli which have many vertebræ undifferentiated and without calcareous material. These fishes are represented only by fin spines (*Onchus*), which may have belonged to something else. These gave rise to Ichthyotomi, with jointed fins, and through these to Dipnoi and a long series leading to the bony fishes on the one hand and on the other to the Amphibia, Reptiles and Higher Vertebrates.

The branch of higher sharks would lead to the Diplospondyli of Hasse's system, of which *Cladoselache* should be a primitive example. These sharks have the weakly ossified vertebræ joined together in pairs and there are six or seven gill openings. This primitive type called Notidani has persisted to our day, the frilled shark (*Chlamydoselachus*) and the genera *Hexanchus* and *Heptranchias,* still showing its archaic characters.

Here the sharks diverge into two groups, the one with the vertebræ better developed and its calcareous matter arranged star fashion. This forms Hasse's group of Asterospondyli, the typical sharks. The earliest forms (Heterodontidæ, Hybodontidæ) approach the Notidani, and one such ancient type *Heterodontus,* still persists. The others diverge to

form the three chief groups of cat-sharks (*Scyliorhinus*, etc.), mackerel-sharks (*Lamna*, etc.) and iron-sharks (*Carcharhias*, etc.).

In the other group the vertebræ have their calcareous matter arranged in rings, one or more about the notochordal center. In all these the anal fin is absent, and in the process of specialization, is formed the flattened body and broad fins of the ray. This group is called Tectospondyli. Hasse's Cyclospondyli (sharks with one ring of calcareous matter) constitute the most primitive extreme of a group representing continuous evolution.

From *Cladoselache* and *Chlamydoselachus* through the sharks to the rays we have an almost continuous series which reaches its highest development in the devil rays or mantas of the tropical seas, *Manta* and *Mobula* being the most specialized genera and among the very largest of the fishes. However different the rays and skates may appear in form and habit, they are structurally similar to the sharks and have sprung from the main shark stem.

The most ancient offshoot from the shark stem, perhaps dating before Silurian times and having its root in ancient Ichthyotomi, is the group of Holocephali or chimæras, shark-like in essentials, but differing widely in details. Of these there are but few living forms, and the fossil types are known only from dental plates and fin spines. The living forms are found in the deeper seas, the world over, the most primitive genus being the newly discovered *Rhinochimæra*. The fusion of the teeth into overlapping plates, the covering of the gills by a dermal flap, the complete union of the palatoquadrate apparatus or upper jaw with the skull and the development of a peculiar clasping spine on the forehead of the male are characteristic of the chimæras. The group is one of the most ancient, but with the chimæras it ends, for the species has nothing in common with modern fishes except what both have derived from their common ancestors the sharks.

The most important offshoot of the primitive sharks is not the chamæras, nor even the shark series itself, but the group of dipnoans or lung-fishes and the long chain of their descendants. With the dipnoan appears the lung or air-bladder, at first an outgrowth from the ventral side of the oesophagus, as it still is in all higher animals, but later turning over, among fishes, and springing from the dorsal side. At first an arrangement for breathing air, a sort of accessory gill—it becomes the sole organ of respiration in the higher forms, while in the bony fishes its respiratory function is lost altogether. The air-bladder is a degenerate gill. In the dipnoans the shoulder girdle moves forward to the skull, and the pectoral limb, a jointed and fringed archipterygium, apparently derived from ancestors of the type of *Pleuracanthus* is its characteristic appendage. The shark-like structure of the mouth remains.

The few living lung fishes resemble the salamanders almost as closely as they do fishes, and they may well be ranged as a class by themselves midway between the primitive sharks and the amphibians. The few living forms show these intermediate characters in the development of lungs and the primitive character of the pectoral and ventral limbs. Those now extant give but little idea of the great variety of extinct dipnoans, but the obvious suggestion that with the lung fish is the place of divergence of the higher vertebrates from the fish series may be the correct one. The living genera are three in number, *Neoceratodus* in Australian rivers, *Lepidosiren* in the Amazon and *Protopterus* in the Nile. These are all mud fishes, some of them living through most of the dry season encased in a cocoon of dried mud. Of these forms *Neoceratodus* is certainly the nearest to the ancient forms, but its embryology, owing to the shortening of its growth stages due to its environment, has thrown little light on the question of its ancestry.

From some branch of the dipnoans the ancestry of the amphibians and through them that of the reptiles, birds and mammals may be traced, although some reason exists for regarding the primitive *Crossopterygium* as the point of divergence. It may be that the Crossopterygian gave rise to Amphibian and Dipnoan alike.

In the process of development we next reach the characteristic fish mouth in which the upper jaw is formed of maxillary and premaxillary elements distinct from the skull. The upper jaw of the shark is part of the palate, the palate being fused with the quadrate bone which supports the lower jaw. That of the dipnoan is much the same. The development of a typical fish mouth is the next step in evolution and with its appearance we note the decline of the air-bladder in size and function.

The next great offshoot is the group of crossopterygians, fishes which still retain the old-fashioned type of pectoral and ventral fin, the archipterygium. In the archaic tail, enameled scales and cartilaginous skeleton the crossopterygian shows its affinity with its dipnoan ancestry. Thus these fishes unite in themselves traits of the shark, lung-fish and Ganoid. The few living crossopterygians, *Polypterus,* and *Erpetoichthys* are not very different from those which prevailed in Devonian times. The larvæ possess external gills with firm base and fringe-like rays, suggesting a resemblance to the pectoral fin itself which develops from the shoulder-girdle just below it and would seem to give some force to Kerr's contention that the archipterygium is only a modified external gill. In *Polypterus* the archipterygium has become short and fan-shaped, its axis made of two diverging bones with flat cartilage between. From this type it is thought that the arm of the higher forms has been developed. The bony basis may be the humerus,

from which diverge radius and ulna, the carpal bones being formed of the intervening cartilage.

From the crossopterygians springs the main branch of true fishes, known collectively as Actinopteri, those with ordinary rays on the paired fins instead of the jointed archipterygium. The transitional series of primitive Actinopteri is here called by the name of Ganoid. The ganoid differs from the Crossopterygian in having basal elements of the paired fins small and concealed within the flesh. But other associated characters of the Crossopterygii and Dipnoi are preserved in most of the species. Among these are the mailed head and body, the heterocercal tail, the cellular air-bladder, the presence of valves in the arterial bulb, the presence of a spiral valve in the intestine and of a chiasma in the optic nerves. All these characters are found in the earlier types so far as known, and all are more or less completely lost or altered in the teleosts or bony fishes. Among the existing ganoids the gar-pike (*Lepisosteus*) is the last of a long series of Mesozoic forms of the same general structure. The gar-pikes are cylindrical or arrow-shaped. Among these early types is every variety of form, some of them being almost as long as deep, and every intermediate form being represented. An offshoot from this line is the bow-fin (*Amia calva*), perhaps the closest living ally of the bony fishes, showing distinct affinities with the great group to which the herring and salmon belong. Near relatives of the bow-fin flourished in the Mesozoic, among them some with a forked tail, and some with a very long one. From forms of this type the body of recent fishes may be descended.

Another branch of ganoids, widely divergent from both gar-fish and bow-fin and not recently from the same primitive stock, included the sturgeons (*Acipenser, Scaphirhynchus, Kessleria*) and the paddle-fishes (*Polyodon* and *Psephurus*). These differ widely from any other types, recent or fossil, showing features of degeneration as compared with their extinct ancestors, while again sturgeon and paddlefish differ widely from each other. It has been suggested that the cat-fishes (Siluridæ) are descended from the sturgeons, but the resemblance vanishes the more closely the groups are compared, nor are we anywhere sure of the point where any part of the teleost series is joined to the ganoids. We can only say that the sturgeons are more or less degraded ganoids with cartilaginous skeletons, of unknown derivation and of unsettled relationships.

All other fishes have ossified instead of cartilaginous skeletons. The dipnoan and ganoid traits one by one are more or less completely lost. Through these the main line of fish development continues and the various groups are known collectively as bony fishes or teleosts.

The earliest of the true bony fishes or teleosts appear in Mesozoic times, the most primitive forms being soft-rayed fishes with unmodi-

fied vertebræ, allied more or less remotely to the herring of to-day. In these and other soft-rayed fishes the pelvis still retains its posterior insertion, the ventral fins being said to be abdominal. The next great stage in evolution brings the pelvis forward, attaching it to the shoulder girdle so that the ventral fins are now thoracic as in the perch and bass. If brought to a point in front of the pectoral fins, a feature of specialized degradation, they become jugular as in the cod-fish. In the abdominal fishes the air bladder still retains its rudimentary duct joining it to the oesophagus.

From the abdominal forms allied to the herring, the huge array of modern fishes, typified by the perch, the bass, the mackerel, the wrasse, the globe-fish, the sculpin, the seahorse and the cod descended in many diverging lines. The earliest of the spine-rayed fishes with thoracic fins belong to the type of Berycidæ, a group characterized by rough scales and the retention of the primitive larger number of ventral rays. These appear in the Cretaceous or chalk deposits, and show various attributes of transition from the abdominal to the thoracic type of ventrals.

Another line of descent apparently distinct from that of the herring and salmon extends through the characins to the loach, carps, cat-fishes and electric eel. The fishes of this series have the anterior vertebræ coossified and modified in connection with the hearing organ, a structure not appearing elsewhere among fishes. This group includes the majority of fresh-water fishes. Still another great group, the eels, have lost the ventral fins and the bones of the head have suffered much degradation.

The most highly developed fishes, all things considered, are doubtless the allies of the perch, bass and sculpin. These fishes have lost the air-duct and on the whole they show the greatest development of the greatest number of structures. But they do not represent an excessive degree of specialization. In other groups their traits one after another are carried to an extreme and these stages of extreme specialization give way one after another to phases of degeneration. The specialization of one organ usually involves degeneration of some other. Extreme specialization of any organ tends to render it useless under other conditions and may be one step toward its final degradation.

We have thus seen, in hasty review, that the fish-like vertebrates spring from an unknown and possibly worm-like stock,—that from this stock, before it became vertebrate, degenerate branches have fallen off, represented to-day by the *Tunicates* and *Balanoglossus*. We have seen that the primitive vertebrate was headless and limbless without hard parts. The lancelet remains as a possible direct off-shoot from it; the cyclostome with brain and skull is a probable derivative from archaic lancelets. The earliest fishes leaving traces in the rocks were doubtless cyclostomes, limbless, naked lampreys and mailed ostracophores. The

lampreys gave rise to sharks and chimæras. The sharks developed into rays in one right line, and into the highest sharks along another; while by a side branch through lost stages the primitive sharks passed into dipnoans or lung-fishes. All these types and others abound in the Devonian age and the early records were lost in the Silurian. From the lung-fishes or the ancestors or descendants by the specialization of the lung and limbs, the land animals, at first amphibians, after these reptiles, birds and mammals, arose.

In the sea, by a line still more direct, through the gradual emphasis of fish-like characters, we find developed the crossopterygians with archaic limbs and after these the ganoids with fish-like limbs but otherwise archaic; then the soft-rayed and finally the spiny-rayed bony fishes which culminate in specialized and often degraded types, as the anglers, globe-fishes, parrot-fishes and flying gurnards. Side branches are the ostracophores, perhaps from primitive lampreys; arthrognaths from a lost ancestry possibly; chimæras, from primitive sharks, and rays from sharks less primitive; dipnoan sturgeons, gar-pikes and perhaps carp and cat-fishes; and from each of the ultimate lines of descent radiate infinite branches till the sea and rivers are filled, and almost every body of water has fishes fitted to its environment.

SCIENTIFIC LITERATURE.

BIOGRAPHIES OF EMINENT CHEMISTS.

THE literature of chemistry has recently been enriched by several biographies of chemists and by carefully edited works reproducing the letters that passed between certain chemists; the importance and value of these volumes is enhanced by the reflection that the history of the lives of the leading men in a growing science constitutes the most complete history of the science in that period during which they labored, and their lives and labors are reflected in their letters. These notions are appreciated by most of the editors of the correspondence we have in mind, and they make their tasks of double value by introducing numerous bibliographic and explanatory notes.

No student of the progress of chemistry in France during the second quarter of the century just closed can acquire a full and correct knowledge of the subject without a perusal of the life of Charles Gerhardt, edited by his son (bearing the same name), and by Edouard Grimaux (Paris, 1900). In his short life of only forty years, Gerhardt introduced ideas into chemistry that were at first thought to be revolutionary, but were eventually adopted even by his adversaries; his services to organic chemistry were of the highest importance; he first doubled the atomic weights of carbon, oxygen and sulfur, divided acids according to their basicity, and completely established the individuality of the equivalent, the atom and the molecule.

Of a very different type was his contemporary living across the Rhine, Schönbein, whose life has been sympathetically written by his successor in the University chair, Dr. Geo. W. A. Kahlbaum (Leipzig, 1899–1901, 2 vols.). The painstaking, indefatigable discoverer of ozone, of gun-cotton, of collodion, and of the passive state of iron, forms a strong contrast to the brilliant, keen-sighted investigator in organic chemistry, Gerhardt. Schönbein's busy yet uneventful life reaped but a paltry reward for a discovery that subsequently brought the Swedish manufacturer a colossal fortune; but none knew better than Schönbein that the reward sought by the investigator in the chemical laboratory is success in wresting from nature her hidden truths.

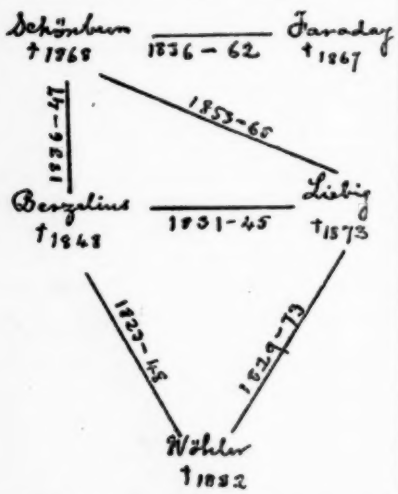
Schönbein was a voluminous writer of letters; Dr. Kahlbaum made a collection of over 1,600, besides 350 printed papers, and analyzed them carefully in compiling the volumes named. One of his most regular and valued correspondents was Faraday, and the letters interchanged with him have been published in another volume edited by Dr. Kahlbaum and Francis V. Darbishire (Bâsle and London, 1899). These letters number 155 and cover the period from 1836 to 1862, beginning with a letter from Schönbein announcing the peculiar behavior of iron in nitric acid of a certain strength, and ending with a brief note from Faraday that painfully discloses his mental distress. The first mention of a 'phosphorus smell developed by electricity' occurs in a letter to Faraday dated April 4, 1840, and the exciting cause of this odor occupies some part of nearly every letter to Faraday during the succeeding twenty-two years.

Dr. Kahlbaum, with others, has published 'Twenty Letters,' exchanged by Schönbein and Berzelius in the years 1836 to 1847 (Bâsle, 1898), and the

same in an English dress (London, 1900), also the 'Letters of Schönbein and Liebig, 1853–1869' (Leipzig, 1898), so that the correspondence of Schönbein is largely accessible to students seeking details.

These several volumes of correspondence suggest others that are analogous. The 'Letters of Berzelius and Liebig, 1831 to 1845,' edited by Justus Carrière with the cooperation of the Bavarian Academy of Sciences (Munich, 1893), and the correspondence between Berzelius and Wöhler, published by the Royal Academy of Göttingen, and edited by O. Wallach (Leipzig, 1901, 2 vols.).

And to complete this series of letters that passed between eminent chemists there remains the 'Correspondence of Liebig and Wöhler,' edited by A. W. von Hofmann, and Emilie Wöhler (Braunschweig, 1888, 2 vols). These cover the long period from 1829 to 1883. The inter-relations of these six works with the dates of the correspondence and of the death of each chemist, may be graphically shown by a diagram.



The perusal of letters between intimate friends having mutual interests in kindred studies is much like listening to conversation carried on between them; they reveal their daily life, domestic happiness and difficulties, their likes and dislikes, their humor and their satire, their successes and failures in research, and their ambitions and discouragements. They also disclose their weaknesses and perhaps their foibles, and they unconsciously divulge the greatness of their intellects, all in simple language, not written to produce startling effects nor to exaggerate their own importance in the minds of readers.

All these volumes are illustrated by one or more portraits, and some of them contain facsimiles of manuscripts.

MOSQUITOES.

A MONOGRAPH of the 'Culicidæ or Mosquitoes of the World' has just been prepared by Mr. Fred. V. Theobald, and is published by the British Museum as one of its regular series. There are two volumes of text aggregating 835 pages and one volume of plates, numbering 37 and containing 148 colored figures of adults. Then there are 5 plates, each containing six solar prints of microphotographs illustrating wing scales. In the text are 318 woodcuts, half-tones or similar figures. In these books 258 species of mosquitoes, divided among 22 genera, are described, and 37 species in 10 genera are credited to North America. Although the work is just off the press it is already out of date, and in the introductory remarks by the director of the museum, dated November, 1901, a supplementary volume is promised. All these facts indicate the remarkable interest that has been of late universally aroused in the subject, and the enormous collections that have been and are now being made in all parts of the world. In the United States several new species were recognized and described in 1901, two of them from New Jersey. The life history of several species has been made out, and good structural characters for their separation appear as the result of American study. Mr. Theobald describes 136 new species; almost as many as were described in all previous

times, and he indicates the possession of something like 50 additional forms.

Almost 100 pages are devoted to the peculiarities of mosquitoes in all stages, and to the methods to be employed in studying them. The mouth structures are explained in the conventional way and the matter of food is gone into somewhat in detail. Of course comparatively few mosquitoes ever get a meal of blood, and yet it would seem that for some species such a meal is an essential preliminary to reproduction. All sorts of vertebrates may be attacked, even fish and reptilia, and invertebrates seem almost as susceptible. The males, being unable to puncture either animal or vegetable tissue, are confined to a diet of prepared liquids—nectar and the like—but do not despise others, like beer and wine, when they can get them.

To mosquitoes as disease carriers only a few pages are devoted; the author referring to such writings as Ross's, Grassi's, Nuttall's and others. He specifically discusses 'Malaria,' filariasis and yellow fever, though adding nothing from personal observation. Birds and probably some animals suffer from diseases carried by these insects and usually only one, or a small group of species, acts in the transmission. Thus the species of *Anopheles*, in America at least, is responsible for the distribution of *malarial* troubles, while *Stegomyia* appears to do as much for yellow fever.

Mr. Theobald emphasizes the character of the scales on certain portions of the head, wing and body, which assists in separating species. This brings into play the microscope and, practically, that instrument must be resorted to for final determinations in some instances.

It is altogether a very interesting and useful book to the entomologist who wishes to learn what has been done in this family and who has done it. The plates are too highly colored and the figures are, therefore, misleading. The text figures, illustrating structural details, are as a whole only fair, though the point to be illustrated is always well brought out. The book-maker's work is well done, and so is the printer's, while a good index adds materially to the facility with which the book may be used by the reader.

MECHANICS.

AN 'Elementary Treatise on Theoretical Mechanics' by Professor W. Woolsey Johnson (Wiley and Sons, New York) is far from elementary, as the reader is supposed to have a good knowledge of differential and integral calculus. The laws of nature are, however, quite independent of any system of mathematics, and many of those discussed in this volume might be easily treated by elementary algebra and geometry. There can be no objection to the use of the calculus if its demonstrations are simpler than those of common methods, but the combination of difficult mathematics with difficult subject-matter should be avoided in an elementary text-book. The plan of the book is that usual in this subject, forces being discussed at much length, in connection with the time-rate of space or velocity, before the subject of work or energy is taken up. This plan follows the historical line of development, but it is questionable whether it is the best method for the student or for getting at practical solutions. The book contains no unsound doctrine, is concisely written in a scholarly tone, and is an able presentation of the subject under the plan adopted.

THE PROGRESS OF SCIENCE.

THE JOHNS HOPKINS UNIVERSITY.

On February 21 and 22 the Johns Hopkins University celebrated the twenty-fifth anniversary of its founding and the installation of its second president. In Europe, where the life of a university is measured by centuries, it may be looked on as a sign of crudeness for us to celebrate the tenth or the twenty-fifth anniversary of the establishment of a university. It is, however, a notable fact that universities such as the Johns Hopkins or Chicago should have surpassed so quickly most of the great European institutions not only in size and wealth, but also in their real contributions to higher education and the advancement of knowledge. The Johns Hopkins University will always occupy an important place in the history of the American university. The opportunity given by an endowment unhampered by restrictions or precedents was fully grasped by President Gilman. He called together a small group of professors — Sylvester, Rowland, Remsen and Martin in the sciences— unequaled as leaders in research. By the establishment of a system of fellowships, a group of students was gathered together who have since represented the most advanced work of the country. In the erection of cheap buildings equipped with expensive apparatus, in the creation of working seminar libraries in place of a museum of books, in the establishment of scientific journals and in other ways, the university set an excellent example. But its chief claim to our honor is the supreme place it gave to advanced work and investigation by both teachers and students. In the recent establishment of a medical school the same methods have been followed, and the university has again led in a great forward movement.

On the first day of the exercises at Baltimore, Dr. D. C. Gilman, who guided the university during its twenty-five years and has now undertaken an equally important office in the presidency of the Carnegie Institution, gave a commemoration address. On the second day, Dr. Ira Remsen, who has been professor of chemistry since the opening of the university, was formally installed as president, and gave the inaugural address. Both addresses were of great interest not only to those who have been connected with the university, but also to all who are interested in higher education. The addresses will be found in the issue of *Science* for February 28, and will doubtless be published by the University. In addition to these two addresses, there was a reception, a luncheon at the hospital, a dinner by the alumni and other events. Degrees were conferred on a number of university presidents and others. Of the six to whom the doctorate of laws was awarded, on the ground of their association in carrying on the work of the university, five are men of science—Dr. J. S. Billings, Dr. G. Stanley Hall, Professor J. W. Mallet, Dr. C. D. Walcott and Professor Simon Newcomb. The same degree was given to four alumni, including Professor Josiah Royce and Professor E. B. Wilson.

THE NATIONAL MUSEUM.

It is to be hoped that the urgent recommendation for the enlargement of the U. S. National Museum made to congress by Secretary Langley will receive consideration. The present building is truly a scandal. Specimens of

great value are exhibited—most of them are as a matter of fact stored out of view—in inflammable sheds. The secretary makes a comparison with the American Museum of Natural History in New York City, which shows that while the number of specimens in the National Museum is more than double the number in the American Museum, the space of the American Museum is ten times as great as that of the National Museum, and the cost of the buildings was also ten times as great. If New York City spends $4,000,000 on its museum buildings, it seems strange that the general government can not do at least as much. Our national government has been extremely liberal in its appropriation for scientific purposes, surpassing in this respect other governments, but for some reason—probably by mere accident—the museum has been neglected. Washington is becoming a scientific center, rivaling London, Paris and Berlin, but compared with the museums maintained in these cities by the government our national museum is not creditable. The collections though large are not systematic, having resulted from expeditions, gifts and the like, while no appropriations have been available to fill in the gaps which always arise when collections are formed by such methods. The curators do not receive adequate salaries; indeed, of the twenty-one curators, twelve serve without any salary at all, and the average salary of the others is only about $2,500. The keepers of the British Museum of Natural History receive salaries of $4,000. It should be only necessary to point out these matters to congress in order that appropriations may be made for the National Museum commensurate with those of foreign governments. The difficulty is that there are no members of congress who are scientific men, or who are primarily interested in science, such as are to be found in all foreign legislatures, and there is consequently no one who will present to congress the consensus of opinion of scientific men.

A NEW BRITISH ACADEMY.

NATIONAL Academies had more important functions in the past than they have now. Still the honor of being officially recognized as one of a small body of eminent men may be a stimulus to scientific work, and academies may be among the best existing means of forwarding international relations. Neither in the United States nor in Great Britain has an academy of letters arisen. It seems, however, that a British Academy for the promotion of historical, philological and philosophical studies will soon be established by royal charter. The question of such an academy has been discussed in England since the organization in 1899 of the International Association of Academies. Literary as well as scientific academies are part of this association, and Great Britain can only be represented by the Royal Society. The International Association will hold its next meeting in London in 1904, and the lack of representation of historical and literary studies would thus be emphasized. The question arose as to whether the Royal Society might be enlarged to include students of history, economics, philology, etc., as was apparently intended by the original charter of King Charles II. Many members of the Society favored the plan, but it was rejected by the council. It is probable that the leading English students of the humanities from the scientific side will be permitted to organize themselves into an academy, and that there will hereafter be in Great Britain a new Royal Academy as well as a Royal Society. The National Academy of Sciences was intended to include students of economics, philology and similar sciences, but the few representatives of these sciences have died and no successors have been elected. It seems likely that, unless the National Academy decides to give

recognition to sciences other than those commonly called natural and exact, the conditions that prompted the establishment in England of a special Academy may lead to a similar undertaking in the United States. The national societies devoted to history, economics, philology, archeology and the like fill most of the important functions that were formerly exercised by a national academy, but there appears to be as much reason for the students of these sciences to unite in a national academy as there is in the case of the natural sciences. There seems also reason to suppose that the societies referred to will form some basis of cooperation as the natural sciences have done by uniting in the American Association. Whether all the sciences should unite in one national academy and in one national association or whether they should divide into two separate groups is certainly a question of considerable importance.

THE GERMICIDAL ACTION OF THE ORGANIC PEROXIDES.

DRS. F. G. NOVY and P. C. FREER, of the University of Michigan, presented at the Chicago meeting of the American Society of Bacteriologists an important paper that has been extensively, but not very accurately, reported in the daily papers. The authors stated that their investigation was begun with the object of finding the correct explanation of the action of metals and of sunlight upon bacteria. Certain metals, such as gold and copper, exert a marked inhibiting and even germicidal effect upon some bacteria, but the interpretation of the results has not been wholly satisfactory. The fact that various surfaces, such as metals and fabrics, exert a marked effect upon the formation of benzoyl acetyl peroxide was established by the authors and served as a basis for the view that metals act upon bacteria by giving rise to energetic peroxides, which, of necessity, must be more active than ordinary peroxides. The action of sunlight has been ascribed by different workers to hydrogen peroxide, but the destructive action observed is greater than that which can be credited to this body. In order to substantiate the theory of the authors regarding the action of metals and of sunlight, it was deemed necessary to investigate the action of a number of known organic peroxides. The results show that some of these bodies, such as aceton peroxide and dibenzoyl peroxide, are wholly inert. On the other hand, solutions of diacetyl, benzoyl acetyl, and of benzoyl hydrogen peroxides, and of phthalmonoperacid, exert pronounced and even remarkable germicidal properties. With reference to diacetyl peroxides and benzoyl acetyl peroxide, it was shown that the bodies themselves are chemically and bacterially inert, but on contact with water they undergo hydrolysis and give rise to the extremely energetic acetyl hydrogen and benzoyl hydrogen peroxides. A solution of these peroxides (1: 3,000) is capable of destroying all pathogenic bacteria. Cholera and typhoid germs added to tap water are promptly destroyed by the addition of one part of peroxide to 100,000 parts of water. The authors point out the probable value of these peroxides in the prevention and cure of these and allied diseases. The destruction of bacteria in the mouth and saliva takes place with extraordinary rapidity and the reagents have shown themselves useful in diseases of the mouth. The powerful effects of the organic peroxides is not explainable as due to nascent oxygen, since a solution of hydrogen peroxide, which will produce equal germicidal action, contains one or even two hundred times as much nascent oxygen. The authors incline to the belief that the acetyl and benzoyl ions are the active agents.

TWILIGHT IN THE TROPICS.

PROFESSOR S. I. BAILEY, of the Harvard College Observatory, presented a

paper at the Washington meeting of the Astronomical and Astrophysical Society of America, in which he said that if there were no atmosphere, there would be no twilight, and the brightness of midday would be succeeded, the moment after sunset, by the darkness of midnight. Twilight may be said to last until the last bit of illuminated sky disappears from the western horizon. In general it has been found that this occurs when the sun has sunk about 18° below the horizon. The duration of time which the sun takes in reaching this position is very different at different latitudes. At the North Pole one would have about six months of daylight, followed by nearly two months of decreasing twilight, followed in turn by more than two months of night. In summer, at latitudes greater than 50°, twilight lasts from sunset to sunrise. There is no night there during this season. In the temperate zones the duration of twilight ranges from an hour and a half to more than two hours. Within the tropics the sun descends nearly or quite vertically; but even here the time required for the sun to reach a point 18° below the horizon is more than an hour. There seems to be no reason, therefore, in the general theory, for the widespread belief that the duration of the tropical twilight is extremely brief. This idea is found not only in current popular literature, but also in some of the best text-books on general astronomy. Young's 'General Astronomy,' says: "At Quito and Lima it (the twilight) is said to last not more than twenty minutes." 'The Heavens Above,' by Gilbert and Rolfe, remarks: "Within the tropics, where the air is pure and dry, twilight sometimes lasts only fifteen minutes." Since Arequipa, Peru, lies within the tropics and has an elevation of 8,000 feet, and the air is especially pure and dry, the conditions appear to be exceptionally favorable for an extremely short twilight. On Sunday, June 25, 1899, the following observations were made at the Harvard Astronomical Station, which is situated there: The sun disappeared at 5:30 P.M., local mean time. At 6:00 P.M., 30 m. after sunset, I could read ordinary print with perfect ease. At 6:30 P.M. I could see the time readily by an ordinary watch. At 6:40 P.M., 70 m. after sunset, the illuminated western sky was still bright enough to cast a faint shadow of an opaque body on a white surface. At 6:50 P.M. the illumination was faint, and at 6:55 P.M., 1 h. and 25 m. after sunset, it had disappeared. On August 27, 1899, the following observations were made at Vincocaya. The latitude of this place is about 16° south, and the altitude 14,360 feet. Here it was possible to read coarse print 47 m. after sunset, and twilight could be seen for an hour and twelve minutes after the sun's disappearance. It appears, therefore, that while the tropical twilight is somewhat shorter than occurs elsewhere, and is still further lessened by favorable conditions, such as great altitude and a specially pure air, it is never less, and generally much longer, than an hour.

A GENUS OF GREAT ANTIQUITY.

THE number of genera which came into existence in early geological times and have persisted until the present day is very small, and a study of the recent representatives of such genera is always of interest. The gasteropod genus, Pleurotomaria, made its appearance during the lower Cambrian period and is represented in the seas of to-day by at least four species, *P. Quoyana*, *P. Adansoniana*, *P. Beyrichii* and *P. Rumphii*. These species were founded on the characters of the shells alone, and the animal remained unknown until 1871, when Professor Louis Agassiz dredged a specimen of *P. Quoyana* off the Barbadoes in about 100 fathoms. Additional specimens of both *Quoyana* and *Adansoniana* were obtained by the 'Blake' under the direction of

Mr. Alexander Agassiz in 1879 and have been described by Dr. Dall and by MM. Bouvier and Fischer. More recently several specimens of *P. Beyrichii* have been taken off the coast of Japan from a depth of 70 to 80 fathoms and have formed the basis of a description by Mr. Martin F. Woodward, which appears in a recent number of the 'Quarterly Journal of Microscopical Science' (March, 1901).

As might be expected from its great antiquity, Pleurotomaria presents a number of primitive characteristics which throw considerable light upon the affinities of the different groups of the Mollusca. Possessing two gills, two kidneys and two auricles to the heart, it belongs to the suborder termed Diotocardia zygobranchia, a group which also includes the genera Haliotis and Fissurella; and which, on account of the approximation of its members to a greater degree of bilateral symmetry than is found in the majority of the Gasteropods, is generally regarded as being the most primitive group of its order. In several respects, however, Pleurotomaria is found to possess structural characters of a more primitive nature than those found in other diotocardiates and appears to stand in closer relation to the main line from which the monotocardia have diverged than any other recent genus.

It would require more space than can be allowed here to mention all the important results obtained by Mr. Woodward, but attention may be called (1) to the primitive condition of the nervous system, whose cells are scattered along the various connectives and are not aggregated into definite ganglia—a condition recalling that obtaining in the Amphineurous Mollusca; and (2) to the peculiar position of the supporting skeleton of the gills, which, taken into consideration with the occurrence of a well-developed spinal cæcum attached to the stomach, suggests to Mr. Woodward's mind a comparison and possibly an affinity with the Cephalopods, in which similar conditions exist.

SCIENTIFIC ITEMS.

THE students of the University of California held memorial exercises in honor of the late Professor Joseph Le Conte on February 26, the anniversary of his birth. Funds are being collected to assist in the erection of a granite lodge which the Sierra Club proposes to construct in the Yosemite Valley as a memorial to Dr. Le Conte.—Plans have been formed for the erection of a memorial tower and meteorological station in honor of Dr. J. P. Joule, F.R.S., at Sale, Cheshire, where he lived from 1872 to the time of his death in 1880.

PROFESSORS WILLIAM JAMES and W. Wundt, the eminent psychologists, and Professor James Dewar, the eminent chemist, have been elected honorary members of the New York Academy of Sciences.—Professor Hermon C. Bumpus has been appointed director of the American Museum of Natural History, New York.—Professor W. H. Brewer, for thirty-seven years professor of agriculture in the Sheffield Scientific School of Yale University, will retire from the active duties of the professorship at the end of the present academic year.

IT will be remembered that Mr. J. Pierpont Morgan gave last year $1,000,000 for the rebuilding of the Harvard Medical School. An equal sum has recently been given by Mr. John D. Rockefeller, and nearly the same amount has been given by others, including $250,000 from Mrs. C. P. Huntingdon and $100,000 from Mr. James Stillman.

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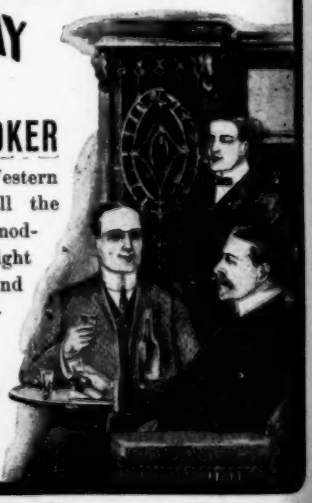

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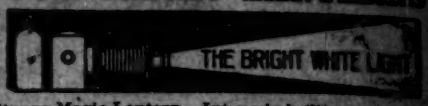

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